



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management

DFCM

Request for Proposals for Construction Services

Value Based Selection Method
(No Management Plan)

July 18, 2006

HEATING PLANT BOILER # 3 REPLACEMENT

**SNOW COLLEGE
EPHRAIM, UTAH**

DFCM Project No. 06166700

Intermountain Consumer Professional Engineers
1145 East South Union Avenue
Midvale, Utah 84047
(801) 255-1111

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Current copies of the following documents are hereby made part of these contract documents by reference. These documents are available on the DFCM web site at <http://dfcm.utah.gov> or are available upon request from DFCM.

DFCM General Conditions dated May 25, 2005

DFCM Application and Certificate for Payment dated May 25, 2005.

Technical Specifications:

Drawings:

The Agreement and General Conditions dated May 25, 2005 have been updated from versions that were formally adopted and in use prior to this date. The changes made to the General Conditions are identified in a document entitled Revisions to General Conditions that is available on DFCM's web site at <http://dfcm.utah.gov>

NOTICE TO CONTRACTORS

The State of Utah - Division of Facilities Construction and Management (DFCM) is requesting proposals for the construction of the following project:

HEATING PLANT BOILER #3 REPLACEMENT
SNOW COLLEGE – EPHRAIM, UTAH
DFCM PROJECT NO. 06166700

This project is to remove the existing coal fired boiler and replace it with a new natural gas/oil fired boiler. Some structural modifications to the roof and removal of the coal feed system will be required. Construction cost is estimated at \$666,000.

The Request for Proposals (RFP) documents, including the selection requirements, the selection schedule, and the construction documents, will be available at 8:30 AM on Tuesday, July 18, 2006 from DFCM, 4110 State Office Building, Salt Lake City, Utah 84114, telephone (538)3018, in electronic format only, and on the DFCM web page at <http://dfcm.utah.gov>. For questions regarding this project, please contact Craig Wessman, Project Manager, DFCM, at (801) 538-3246. No others are to be contacted regarding this project.

The procurement shall be under the Value Based Selection RFP method. A **MANDATORY** Pre-Proposal Meeting and site visit will be held at 11:00 AM on Thursday, July 27, 2006 at the Central Heating Plant on the campus of Snow College (approximate address is 250 East 100 North in Ephraim, Utah). All prime contractors wishing to submit on this project must attend this meeting.

Cost proposals must be submitted by 2:00 PM on Tuesday, August 8, 2006 to DFCM at 4110 State Office Building, Salt Lake City, Utah 84114. Additional information, including references, will be required as stated on the Project Schedule. Note: Submittals must be received at 4110 State Office Building by the specified times.

The contractor shall comply with and require all of its subcontractors to comply with the license laws as required by the State of Utah.

A Bid Bond in the amount of five percent (5%) of the proposal amount, made payable to the Division of Facilities Construction and Management on DFCM's bid bond form, shall accompany the cost proposal.

The Division of Facilities Construction & Management reserves the right to reject any or all proposals or to waive any formality or technicality in any proposal in the interest of the State.

DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT
MARLA WORKMAN, CONTRACT COORDINATOR
4110 State Office Bldg., Salt Lake City, Utah 84114

DESCRIPTION OF WORK

The existing coal fired boiler is to be removed. This work will require the removal of the coal feed system, the existing boiler, filling in the tunnels for the coal feed system and leveling the floor for the placement of the new boiler, and new roof structure and roof decking due to shared structural elements between the roof and the coal boiler system. Provide a new boiler which is to be fired with natural gas and no. 2 oil. Piping for the oil and natural gas will be extended from existing systems already in place. Extension of the piping for steam and boiler feed will be to the existing piping systems already in place. The electrical requirements include the removal of the existing conduit and wiring for the boiler and installing new conduit and wiring for the new boiler. Automation of the entire plant is a part of this project. The removal of an infill wall section and the installation of a new overhead door for one existing boiler is also a part of this project.

Project Risk Factors

Project risk factors identified at present include the following:

1. The timely delivery of the boiler and other associated materials.
2. Construction site away from the Wasatch Front.
3. Work will be in an existing structure and the other portion of the boiler plant will be in operation starting approximately October 1.

PROCUREMENT PROCESS

1. Request for Proposal Documents

The Request for Proposal (RFP) documents consist of all of the documents listed in the Table of Contents and all said documents are incorporated in this RFP by reference.

2. Availability of Requests for Proposals

A compact disc containing the full contract documents is available free of charge at the locations stated on the Project Schedule. Contract Documents are available at DFCM's internet web site at <http://dfcm.utah.gov>.

3. Contact Information

Except as authorized by the DFCM Representative or as otherwise stated in the RFP or the pre-proposal meeting, communication during the selection process shall be directed to the specified DFCM Representative. In order to maintain the fair and equitable treatment of everyone, contractors shall not unduly contact or offer gifts or gratuities to DFCM, any Board officer, employee or agent of the State of Utah, users or selection committee members in an effort to influence the selection process or in a manner that gives the appearance of influencing the selection process. This prohibition applies before the RFP is issued as the project is developed, and extends through the award of a contract. Failure to comply with this requirement may result in a disqualification in the selection process. Contractors should be aware that selection committee members will be required to certify that they have not been contacted by any of the contractors in an attempt to influence the selection process.

4. Requests for Information

All requests for information regarding this project shall be in writing and directed to:

Craig Wessman (DFCM Representative)
Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114
E-mail: cwessman@utah.gov
Facsimile: (801) 538-3267

5. Project Schedule

The Project Schedule lists the important events, dates, times and locations of meetings and submittals that must be met by the contractor.

6. Mandatory Pre-Proposal Meeting & Registration

A mandatory pre-proposal meeting will be held on the date and time and at the location listed on the Project Schedule.

A representative from each interested prime contractor is required to attend. During the meeting, a presentation will be made to describe the overall scope of work and intended schedule. Interested prime contractors may ask questions and request clarification about the project and the procurement process.

Subcontractors and suppliers are invited to attend this meeting but it is not mandatory for them.

THE PRIME CONTRACTORS ABSENCE FROM THE PRE-PROPOSAL MEETING AND/OR FAILURE TO REGISTER PRECLUDES PARTICIPATION AS A PROPOSER ON THIS PROJECT.

7. Submittal Due Dates and Times

All required submittals must be delivered to, and be received by, the Division of Facilities Construction and Management previous to the date and time indicated in the Project Schedule. Submittals received after the specified time will not be accepted. Please allow adequate time for delivery. If using a courier service, the contractor is responsible for ensuring that delivery will be made directly to the required location. It is your responsibility to allow for the time needed to park on Capitol Hill as recent construction activity has made the parking more difficult. Identification is required to enter the building.

8. Last Day to Submit Questions

All questions must be received at the office of DFCM no later than the time and dated listed on the Project Schedule. Questions must be submitted in writing to Craig Wessman at DFCM.

9. Addendum

All responses to questions and requests for clarification will be in writing and issued as addenda to the Request for Proposals. The addenda will be posted on DFCM's web site.

Any addenda issued prior to the submittal deadline shall become part of the Request for Proposals and any information required shall be included in your proposal.

10. Past Performance and References

As a contractor completes each DFCM project, DFCM, the architects/engineers and the using agency will evaluate the contractor. It is the intent of DFCM that this process will be the major source for evaluating past performance.

Contractors shall submit past performance and reference information by the time indicated on the Project Schedule.

For all DFCM projects completed in the last five (5) years identify the project by name, number and DFCM project manager. Each contractor wishing to compete for this project that has not completed at least three (3) DFCM projects in the last five (5) years, will be required to provide one copy of a list of references on additional similar projects for a total of three (3) projects.

For non-DFCM projects provide the following information:

Point of Contact:	Person who will be able to answer any customer satisfaction questions.
Phone Number:	Phone number of the contact we will be surveying.
User Name:	Name of the Company / Institution that purchased the construction work.
Project Name:	Name of the project.
Date Completed:	Date of when the work was completed.
Address:	Street, city and state where the work was performed.
Size:	Size of project in dollars.
Duration:	Duration of the project / construction in months.
Type:	Type of the project (i.e.: School, Offices, Warehouse, etc.)

11. Cost Proposal

Before submitting a proposal, each contractor shall carefully examine the RFP; shall visit the site of the Work; shall fully inform themselves as to all existing conditions and limitations; and shall include in the proposal the cost of all items required by the RFP. If the contractor observes that portions of the Contract Documents are at variance with applicable laws, building codes, rules, regulations or contain obvious erroneous or uncoordinated information, the contractor shall promptly notify the specified DFCM Representative and the necessary changes shall be accomplished by Addendum.

The proposal, bearing original signatures, must be typed or handwritten in ink on the Cost Proposal Form provided in the procurement documents and submitted in a sealed envelope at the location specified below prior to the deadline for submission of cost proposals indicated on the Project Schedule.

Bid bond security, in the amount of five percent (5%) of the proposal amount, made payable to the Division of Facilities Construction and Management, shall accompany proposal. THE BID BOND MUST BE ON THE BID BOND FORM PROVIDED IN THE PROCUREMENT DOCUMENTS IN ORDER TO BE CONSIDERED AN ACCEPTABLE PROPOSAL.

If the bid bond security is submitted on a bid bond form other than DFCM's required bid bond form, and the bid security meets all other legal requirements, the contractor will be allowed to provide an acceptable bid bond by the close of business on the next business day following notification by DFCM of submission of a defective bid bond security. NOTE: A cashier's check cannot be used as a substitute for a bid bond.

Cost Proposals will be accepted at the office of DFCM, 4110 State Office Building, Salt Lake City, UT 84114. Late proposals will be disqualified and returned to the proposer unopened. One copy of the cost proposal is required. The contractor shall bid the base bid price and the add alternates.

12. Compliance with Construction Budget

DFCM expects to receive cost proposals that are within the stated construction budget. While all contractors are generally encouraged to submit cost reduction proposals as appropriate, those who are not able to submit a cost proposal within the budget are particularly requested to submit cost reduction proposals to bring the cost within the budget. Contractors may, however, submit cost proposals that exceed the budget but they will be addressed in the manner explained below.

After the deadline for submitting cost proposals, DFCM staff will open proposals to identify those contractors whose cost proposals, net of any potentially acceptable cost reduction proposals, are within the stated budget.

Cost proposals will be kept confidential and will not be disclosed to the selection committee until after the interviews and preliminary deliberations are completed. No information regarding a contractor's cost and cost reduction proposals will be disclosed to competing contractors prior to the completion of the selection process.

Only contractors whose cost proposals, less any potentially acceptable cost reduction proposals, are within the stated budget for the contract will be invited to an interview.

If no proposals are received from responsive and responsible contractors whose cost proposal, less any potentially acceptable cost reduction proposals, are within the stated budget for the contract, DFCM will determine which of the following actions to take:

A. DFCM may increase the stated budget for the contract and proceed with the selection process with only those contractors whose cost proposals, less any potentially acceptable cost reduction proposals, are within the revised budget for the contract. The determination of sources of additional funding and how much the budget will be increased is solely at the discretion of DFCM.

B. DFCM may reduce the scope or requirements of the contract. This will be evidenced in an addendum to the RFP which will also set a new deadline for submitting revised cost proposals and

cost reduction proposals. Only qualified contractors who had previously submitted a cost proposal in accordance with the RFP may be considered in this extended procurement process.

C. DFCM may reject all proposals.

13. Cost Reduction Proposals

Any cost reduction proposals must be submitted on a document entitled Cost Reduction Proposals by the deadline indicated in the Project Schedule. Seven (7) copies of this document must be submitted. It is desired that cost reduction proposals not reduce the durability, functionality or cost efficiency of the facility although proposals that do not meet this standard will be considered. The cost impact of these proposals should be included in the Cost Reduction Proposals document. The amount shown on the base cost proposal should not reflect the cost impact of any cost reduction proposals. The cost reduction proposals will be evaluated by DFCM, the user and the Consultant to determine if they are potentially acceptable. Prior to the interviews, each contractor will be notified as to which of their cost reduction proposals are determined to be potentially acceptable and which ones will not be considered in the selection process. Only those cost reduction proposals that are determined to be potentially acceptable may be presented in the interview. A contractor may not submit additional cost reduction proposals after the deadline. Any new cost reduction ideas that are raised in the interview process that were not submitted prior to the deadline will not be considered in the selection process. The cost reduction proposals that are accepted will be included in the original contract.

DFCM retains the right that, if it determines that a cost reduction proposal is desirable but the proposed change is so substantial that its consideration in the selection process would not allow for the fair and equitable treatment of all contractors, DFCM may, at its option, include the proposed change of contract requirements in an addendum and allow all qualified contractors to submit a new proposal.

14. Listing of Subcontractors

Listing of Subcontractors shall be as required by the Request for Proposals and as summarized in the "Instructions and Subcontractor's List Form", which are included as part of this RFP. The Subcontractors List shall be delivered to DFCM or faxed to DFCM at (801)538-3677 by the date and time stated in the Project Schedule and will be included in the Contract. Requirements for listing additional subcontractors are as follows: **NO ADDITIONAL REQUIREMENTS**

DFCM retains the right to audit or take other steps necessary to confirm compliance with requirements for the listing and changing of subcontractors. Any contractor who is found to not be in compliance with these requirements is subject to a debarment hearing and may be debarred from consideration for award of contracts for a period of up to three years.

15. **Time**

One of the selection criteria will be proposed contract time. The contractor will include in the Statement of Qualifications the schedule for completing the work including any items required by DFCM or the consultant. A completion date prior to January 15, 2007 is requested but not mandatory.

It is anticipated that a contract will be given to the contractor for signature by the date specified in the Project Schedule. The actual notice to proceed will be based on how quickly the contractor returns the contract and the required bonds as well as the resolution of any issues that may arise in the procurement process. The actual completion date will be based on the contractors proposed schedule and the date the contractor received the contract for signature.

All plans, schedules, and the cost proposals are required to reflect the project construction time. Non-compliance with the schedule will not result in automatic disqualification; it will be evaluated by the selection committee in determining the final selection.

Of particular interest and concern are the management team and the ability of the prime contractors to deliver the project within the construction time. Contractors will need to demonstrate the method of delivery and the competency of the individuals who will manage its successful completion.

16. **Statements of Qualifications**

The contractor shall provide three (3) copies of the statements of qualifications by the time indicated on the Project Schedule. The statement of qualifications is a short document that indicates the experience and qualifications of the firm, the project manager and the site superintendent. It should include information on similar projects that have been completed by the firm, project manager and site superintendent. Include the experience and special qualifications that the project manager and site superintendent have that are applicable to this project and/or are part of the project specific selection criteria.

17. **Termination or Debarment Certifications**

The contractor must submit a certification that neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from soliciting work by any governmental department or agency. The contractor must also certify that neither it nor its principals have been terminated during the performance of a contract or withdrew from a contract to avoid termination. If the contractor cannot certify these two statements the firm shall submit a written explanation of the circumstances for review by DFCM. Contractors are encouraged to submit these certifications with the Statement of Qualifications but they may be submitted up until the time the selection is completed.

18. Selection Committee

The Selection Committee will be composed of individuals from the Utah State Building Board, DFCM, the User Agency / Institution, representatives from the design and construction disciplines, and others deemed appropriate by DFCM.

19. Interviews.

Interviews will be conducted with all responsive and responsible contractors except as follows. If more than six (6) contractors submit proposals and meet other requirements, DFCM may convene the selection committee to develop a short list of contractors to be invited to interviews. This evaluation will be made using the selection criteria noted below except that cost will not be considered. The information provided by the past performance/references and statement of qualifications will be the basis for this evaluation.

The purpose of the interview is to allow the contractor to present its qualifications, past performance, plan, schedule and general plan for constructing the project. It will also provide an opportunity for the selection committee to seek clarification of the contractor's proposal.

The proposed primary project management personnel, including the project manager and superintendent, should be in attendance. The project manager is the contractor's representative who will be in daily control of the construction site. The project manager has overall job authority, will be in attendance at all job meetings, and is authorized by the contractor to negotiate and sign any and all change orders in the field, if necessary. Unless otherwise noted, the attendance of subcontractors is at the discretion of the contractor.

The method of presentation is at the discretion of the contractor. The interviews will be held on the date and at the place specified in the Project Schedule.

20. Selection Criteria for VBS Construction

The following criteria will be used in ranking each of the construction firms. The firm that is ranked the highest will represent the best value for the state. The criteria are not listed in any priority order. The selection committee will consider all criteria in performing a comprehensive evaluation of the proposal. Weights have been assigned to each criteria in the form of points.

- A. Cost. **20 POINTS**. The contractor's proposal will be considered with all other criteria to determine the ranking of the firm.
- B. Schedule. **20 POINTS**. The contractor's schedule will be evaluated as to how well it meets the objectives of the project. Unless other objectives are stated the shorter the construction

duration that is evaluated to be feasible while maintaining safety and quality in conformance with the construction documents is preferred. The contractor shall discuss during the interview the project schedule identifying major work items with start and stop dates that are realistic and critical subcontractors and if they have reviewed and agree to the schedule. The overall completion date shown on the schedule will be used in the contract as the contract completion date.

- C. DFCM Past Performance Rating. 25 POINTS. Each construction firm will be given a past performance rating. The rating will be based first on how well the firm did on past projects with DFCM. If a minimum of three DFCM past performance ratings are not available a rating will be established using any DFCM past performance ratings that are available, supplemented by references supplied by the contractor at the time the proposals are submitted.
- D. Strength of Contractor's Team. 15 POINTS. Based on the statements of qualifications, and the interview, the selection team shall evaluate the expertise and experience of the construction firm the project manager and the superintendent as it relates to this project in size, complexity, quality and duration. Consideration will also be given to the portions of the project that the contractor will self perform and the strength brought to the team by critical subcontractors including how they were selected and the success the contractor has had in working with them.
- E. Project Management Approach. 20 POINTS. Based on the information provided in the information presented in the interview the selection team shall evaluate how each team has planned the project and determined how to construct the project in the location and in the time frames presented. The firm should present how they plan to move material and people into and out of the site. Keep the site safe; minimize disruption to the facility etc. The construction firm shall also discuss what portions of the project they plan to self perform. The selection team will also evaluate the degree to which risks to the success of the project have been identified and a reasonable solution has been presented. This may include cost reduction ideas or proposals.

TOTAL POSSIBLE POINTS: 100 POINTS.

21. Award of Contract

The selection of the prime contractor will be made using the Value Based Selection system (VBS). The award of the Contract shall be in accordance with the criteria set forth in the Request for Proposals (RFP). The State of Utah intends to enter into an agreement with the prime contractor to construct the project as outlined. Individual contractors or alliances between two or more contractors are allowed in this process. The State will contract with only one legal entity.

22. Contract and Bond

The contractor's agreement will be in the form bound in the specifications. The contract time will be as indicated in the proposal. The selected contractor, simultaneously with the execution of the contract agreement, will be required to furnish a performance bond and a payment bond, both bearing original signatures, upon the forms provided in the RFP. The performance and payment bonds shall be for an amount equal to one hundred percent (100%) of the contract sum and secured from a company that meets the requirements specified in the requisite forms. Any bonding requirements for subcontractors will be specified in the Supplementary General Conditions.

23. Interpretation of Drawings and Specifications

If any person or entity contemplating submitting a proposal is in doubt as to the meaning of any part of the drawings, specifications or other contract documents, such person shall submit to the specified DFCM Representative a request for an interpretation thereof. The person or entity submitting the request will be responsible for its prompt delivery. Any interpretation of the proposed documents will be made only by addenda. The addenda will be posted on DFCM's web site. Neither DFCM nor A/E will be responsible for any other explanations or interpretations of the proposed documents. A/E shall be deemed to refer to the architect or engineer hired by DFCM as the A/E or consultant for the Project.

24. Licensure

The Contractor shall comply with and require all of its subcontractors to comply with the license laws as required by the State of Utah.

25. Financial Responsibility of Contractors, Subcontractors and Sub-subcontractors

Contractors shall respond promptly to any inquiry in writing by DFCM to any concern of financial responsibility of the contractor, subcontractor or sub-subcontractor.

26. Product Approvals

Where reference is made to one or more proprietary products in the contract documents, but restrictive descriptive materials of one or more manufacturer(s) is referred to in the contract documents, the products of other manufacturers will be accepted, provided they equal or exceed the standards set forth in the drawings and specifications and are compatible with the intent and purpose of the design, subject to the written approval of the Consultant. Such written approval must occur prior to the deadline established for the last scheduled addenda to be issued. The Consultant's written approval will be in an issued addendum. If the descriptive material is not restrictive, the products of other manufacturers specified will be accepted without prior approval provided they are compatible with the intent and purpose of the design as determined by the Consultant.

27. Withdrawal of Proposals

Proposals may be withdrawn on written request received from proposer until the notice of selection is issued.

28. Time is of the Essence

Time is of the essence in regard to all the requirements of the contract documents.

29. Right to Reject Proposals

DFCM reserves the right to reject any or all proposals.

**Division of Facilities Construction and Management****PROJECT SCHEDULE**

PROJECT NAME:		HEATING PLANT BOILER #3 REPLACEMENT		
		SNOW COLLEGE – EPHRAIM, UTAH		
DFCM PROJECT NO.		06166700		
Event	Day	Date	Time	Place
Request for Proposals/ Construction Documents Available	Tuesday	July 18, 2006	8:30 AM	DFCM 4110 State Office Bldg SLC, Utah or DFCM web site *
Mandatory Pre-Proposal Site Meeting	Thursday	July 27, 2006	11:00 AM	Central Heating Plant Snow College 250 East 100 North Ephraim, UT
Last Day to Submit Questions	Tuesday	August 1, 2006	4:00 PM	Craig Wessman DFCM 4110 State Office Bldg SLC, Utah
Final Addendum Issued	Friday	August 4, 2006	4:00 PM	DFCM web site*
Prime Contractors Turn In Cost Proposals, and References	Tuesday	August 8, 2006	2:00 PM	DFCM 4110 State Office Bldg SLC, UT
Sub-Contractor List, Statements of Qualifications, and Cost Reduction Proposals Due	Wednesday	August 9, 2006	2:00 PM	DFCM 4110 State Office Bldg SLC, UT
Short Listing by Selection Committee, if applicable.	NA			
Termination / Debarment Certifications Due		On or Before Date of Interview	NA	
Interviews	Thursday	August 10, 2006	9:00 AM	DFCM 4110 State Office Bldg SLC, UT
Announcement	Thursday	August 10, 2006	4:00 PM	DFCM web site*
Contract Sent to Contractor for Signature	Tuesday	August 15, 2006		

* DFCM's web site address is <http://dfcm.utah.gov>



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management

DFCM

COST PROPOSAL FORM

NAME OF PROPOSER _____ DATE _____

To the Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114

The undersigned, responsive to the "Notice to Contractors" and in accordance with the "Request for Proposals" for the **HEATING PLANT BOILER #3 REPLACEMENT - SNOW COLLEGE EPHRAIM, UTAH – DFCM PROJECT NO. 06166700** and having examined the Contract Documents and the site of the proposed Work and being familiar with all of the conditions surrounding the construction of the proposed Project, including the availability of labor, hereby proposes to furnish all labor, materials and supplies as required for the Work in accordance with the Contract Documents as specified and within the time set forth and at the price stated below. This price is to cover all expenses incurred in performing the Work required under the Contract Documents of which this bid is a part:

I/We acknowledge receipt of the following Addenda: _____

For all work shown on the Drawings and described in the Specifications and Contract Documents, I/we agree to perform for the sum of:

_____ DOLLARS (\$_____)
(In case of discrepancy, written amount shall govern)

I/We guarantee that the Work will be Substantially Complete by **January 15, 2007**, should I/we be the successful proposer, and agree to pay liquidated damages in the amount of **\$300.00** per day for each day after expiration of the Contract Time as stated in Article 3 of the Contractor's Agreement.

This bid shall be good for 45 days after bid opening.

Enclosed is a 5% bid bond, as required, in the sum of _____

The undersigned Contractor's License Number for Utah is _____

Upon receipt of notice of award of this bid, the undersigned agrees to execute the contract within ten (10) days, unless a shorter time is specified in the Contract Documents, and deliver acceptable Performance and Payment bonds in the prescribed form in the amount of 100% of the Contract Sum for faithful performance of the contract. The Bid Bond attached, in the amount not less than five percent (5%) of the above bid sum, shall become the property of the Division of Facilities Construction and Management as liquidated damages for delay and additional expense caused thereby in the event that the contract is not executed and/or acceptable 100% Performance and Payment bonds are not delivered within the time set forth.

Type of Organization:

(Corporation, Partnership, Individual, etc.)

Any request and information related to Utah Preference Laws:

Respectfully submitted,

Name of Proposer

ADDRESS:

Authorized Signature

BID BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

KNOW ALL PERSONS BY THESE PRESENTS:

That _____ hereinafter referred to as the "Principal," and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____ and authorized to transact business in this State and U. S. Department of the Treasury Listed, (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); hereinafter referred to as the "Surety," are held and firmly bound unto the STATE OF UTAH, hereinafter referred to as the "Obligee," in the amount of \$ _____ (5% of the accompanying bid), being the sum of this Bond to which payment the Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH that whereas the Principal has submitted to Obligee the accompanying bid incorporated by reference herein, dated as shown, to enter into a contract in writing for the _____ Project.

NOW, THEREFORE, THE CONDITION OF THE ABOVE OBLIGATION IS SUCH, that if the said principal does not execute a contract and give bond to be approved by the Obligee for the faithful performance thereof within ten (10) days after being notified in writing of such contract to the principal, then the sum of the amount stated above will be forfeited to the State of Utah as liquidated damages and not as a penalty; if the said principal shall execute a contract and give bond to be approved by the Obligee for the faithful performance thereof within ten (10) days after being notified in writing of such contract to the Principal, then this obligation shall be null and void. It is expressly understood and agreed that the liability of the Surety for any and all defaults of the Principal hereunder shall be the full penal sum of this Bond. The Surety, for value received, hereby stipulates and agrees that obligations of the Surety under this Bond shall be for a term of sixty (60) days from actual date of the bid opening.

PROVIDED, HOWEVER, that this Bond is executed pursuant to provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the above bounden parties have executed this instrument under their several seals on the date indicated below, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

DATED this _____ day of _____, 20____.

Principal's name and address (if other than a corporation):

By: _____

Title: _____

Principal's name and address (if a corporation):

By: _____

Title: _____
(Affix Corporate Seal)

Surety's name and address:

STATE OF _____)
COUNTY OF _____) ss.

By: _____
Attorney-in-Fact (Affix Corporate Seal)

On this ____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney-in-fact of the above-named Surety Company, and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20____.

My Commission Expires: _____

Resides at: _____

Agency: _____
Agent: _____
Address: _____
Phone: _____

NOTARY PUBLIC

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General

**Division of Facilities Construction and Management****INSTRUCTIONS AND SUBCONTRACTORS LIST FORM (VBS)**

All proposers shall submit a list of ALL first-tier subcontractors, meeting the following criteria, including the subcontractor's name, bid amount and other information required by these Contract Documents, on the following basis:

PROJECTS UNDER \$500,000 - ALL SUBS \$20,000 OR OVER MUST BE LISTED
PROJECTS \$500,000 OR MORE - ALL SUBS \$35,000 OR OVER MUST BE LISTED

- Any additional subcontractors identified in the Request for Proposals shall also be listed.
- The DFCM Director may not consider any proposal submitted by a proposer if the proposer fails to submit a subcontractor list meeting the requirements of State law.
- List subcontractors for base bid as well as the impact on the list that the selection of any alternate may have.
- Proposer may not list more than one subcontractor to perform the same work.
- Proposer must list "Self" if performing work itself.

LICENSURE:

The subcontractor's name, the type of work, the subcontractor's bid amount, and the subcontractor's license number as issued by DOPL, if such license is required under Utah Law, shall be listed. Proposer shall certify that all subcontractors, required to be licensed, are licensed as required by State law. A subcontractor includes a trade contractor or specialty contractor and does not include suppliers who provide only materials, equipment, or supplies to a contractor or subcontractor.

PROPOSER LISTING 'SELF' AS PERFORMING THE WORK:

Any proposer that is properly licensed for the particular work and intends to perform that work itself in lieu of a subcontractor that would otherwise be required to be on the subcontractor list, must insert the term 'Self' for that category on the subcontractor list form. Any listing of 'Self' on the sublist form shall also include the amount allocated for that work.

'SPECIAL EXCEPTION':

A proposer may list 'Special Exception' in place of a subcontractor when the proposer intends to obtain a subcontractor to perform the work at a later date because the proposer was unable to obtain a qualified or reasonable proposal under the provisions of U.C.A. Section 63A-5-208(4). The proposer shall insert the term 'Special Exception' for that category of work, and shall provide documentation with the subcontractor list describing the proposer's efforts to obtain a bid of a qualified subcontractor at a reasonable cost and why the proposer was unable to obtain a qualified subcontractor bid. The Director must find that the proposer complied in good faith with State law requirements for any 'Special Exception' designation, in order for the proposal to be considered. If awarded the contract, the Director shall supervise the proposer's efforts to obtain a qualified subcontractor bid. The amount of the awarded contract may not be adjusted to reflect the actual amount of the subcontractor's bid. Any listing of 'Special Exception' on the sublist form shall also include amount allocated for that work.

INSTRUCTIONS AND SUBCONTRACTORS LIST FORM
Page No. 2

GROUND FOR DISQUALIFICATION:

The Director may not consider any proposal submitted by a proposer if the proposer fails to submit a subcontractor list meeting the requirements of State law. Director may withhold awarding the contract to a particular proposer if one or more of the proposed subcontractors are considered by the Director to be unqualified to do the Work or for such other reason in the best interest of the State of Utah. Notwithstanding any other provision in these instructions, if there is a good faith error on the sublist form, at the sole discretion of Director, the Director may provide notice to the proposer and the proposer shall have 24 hours to submit the correction to the Director. If such correction is submitted timely, then the sublist requirements shall be considered met.

CHANGES OF SUBCONTRACTORS SPECIFICALLY IDENTIFIED ON SUBLIST FORM:

Subsequent to submission of the subcontractors list, the contractor may change its listed subcontractors only after receiving written permission from the Director based on complying with all of the following criteria.

- (1) The contractor has established in writing that the change is in the best interest of the State and that the contractor establishes an appropriate reason for the change, which may include, but not is not limited to, the following reasons: the original subcontractor has failed to perform, or is not qualified or capable of performing, and/or the subcontractor has requested in writing to be released.
- (2) The circumstances related to the request for the change do not indicate any bad faith in the original listing of the subcontractors.
- (3) Any requirement set forth by the Director to ensure that the process used to select a new subcontractor does not give rise to bid shopping.
- (4) Any increase in the cost of the subject subcontractor work is borne by the contractor.
- (5) Any decrease in the cost of the subject subcontractor work shall result in a deductive change order being issued for the contract for such decreased amount.
- (6) The Director will give substantial weight to whether the subcontractor has consented in writing to being removed unless the contractor establishes that the subcontractor is not qualified for the work.

EXAMPLE:

Example of a list where there are only four subcontractors

TYPE OF WORK	SUBCONTRACTOR, "SELF" OR "SPECIAL EXCEPTION"	SUBCONTRACTOR BID AMOUNT	CONT. LICENSE #
ELECTRICAL	ABCD Electric Inc.	\$350,000.00	123456789000
LANDSCAPING	"Self"	300,000.00	123456789000
CONCRETE (ALTERNATE #1)	XYZ Concrete Inc	298,000.00	987654321000
MECHANICAL	"Special Exception" (attach documentation)	Fixed at: 350,000.00	(TO BE PROVIDED AFTER OBTAINING SUBCONTRACTOR)

**SUBCONTRACTOR BID AMOUNTS CONTAINED IN THIS SUBCONTRACTOR LIST
SHALL NOT BE DISCLOSED UNTIL THE CONTRACT HAS BEEN AWARDED.**

**Division of Facilities Construction and Management****SUBCONTRACTORS LIST****PROJECT TITLE:** _____**Caution:** You must read and comply fully with instructions.

TYPE OF WORK	SUBCONTRACTOR, "SELF" OR "SPECIAL EXCEPTION"	SUBCONTRACTOR BID AMOUNT	CONT. LICENSE #

We certify that:

1. This list includes all subcontractors as required by the instructions, including those related to the base bid as well as any alternates.
2. We have listed "Self" or "Special Exception" in accordance with the instructions.
3. All subcontractors are appropriately licensed as required by State law.

FIRM: _____

DATE: _____

SIGNED BY: _____

NOTICE: FAILURE TO SUBMIT THIS FORM, PROPERLY COMPLETED AND SIGNED, AS REQUIRED IN THESE CONTRACT DOCUMENTS, SHALL BE GROUNDS FOR DFCMS REFUSAL TO ENTER INTO A WRITTEN CONTRACT WITH PROPOSER. ACTION MAY BE TAKEN AGAINST PROPOSERS BID BOND AS DEEMED APPROPRIATE BY DFCM. ATTACH A SECOND PAGE IF NECESSARY.

FUGITIVE DUST PLAN

The Contractor will fill out the form and file the original with the Division of Air Quality and a copy of the form with the Division of Facilities Construction & Management, prior to the issuance of any notice to proceed.

The Contractor will be fully responsible for compliance with the Fugitive Dust Control Plan, including the adequacy of the plan, any damages, fines, liability, and penalty or other action that results from noncompliance.

Utah Division of Air Quality

April 20, 1999

**GUIDANCE THAT MUST BE CONSIDERED IN DEVELOPING AND SUBMITTING A
DUST CONTROL PLAN FOR COMPLIANCE WITH R307-309-3, 4, 5, 6, 7**

Source Information:

1. Name of your operation (source): provide a name if the source is a construction site.
2. Address or location of your operation or construction site.
3. UTM coordinates or Longitude/Latitude of stationary emission points at your operation.
4. Lengths of the project, if temporary (time period).
5. Description of process (include all sources of dust and fugitive dust). Please, if necessary, use additional sheets of paper for this description. Be sure to mark it as an attachment.
6. Type of material processed or disturbed.
7. Amount of material processed (tons per year, tons per month, lbs./hr., and applicable units).

8. Destination of product (where will the material produced be used or transported, be specific, provide address or specific location), information needed for temporary relocation applicants.
9. Identify the individual who is responsible for the implementation and maintenance of fugitive dust control measures. List name(s), position(s) and telephone number(s).
10. List, and attach copies of any contract lease, liability agreement with other companies that may, or will, be responsible for dust control on site or on the project.

Description of Fugitive Dust Emission Activities
(Things to consider in addressing fugitive dust control strategies.)

1. Type of activities (drilling and blasting, road construction, development construction, earth moving and excavation, handling and hauling materials, cleaning and leveling, etc).
2. List type of equipment generating the fugitive dust.
3. Diagram the location of each activity or piece of equipment on site. Please attach the diagram.
4. Provide pictures or drawings of each activity. Include a drawing of the unpaved/paved road network used to move loads “on” and “off” property.
5. Vehicle miles travels on unpaved roads associated with the activity (average speed).
6. Type of dust emitted at each source (coal, cement, sand, soil, clay, dust, etc.)
7. Estimate the size of the release area at which the activity occurs (square miles). For haul or dirt roads include total miles of road in use during the activity.

Description of Fugitive Dust Emission Controls on Site

Control strategies must be designed to meet 20% opacity or less on site (a lesser opacity may be defined by Approval Order conditions or federal requirements such as NSPS), and control strategies must prevent exceeding 10% opacity from fugitive dust at the property boundary (site boundary) for compliance with R307-309-3.

1. Types of ongoing emission controls proposed for each activity, each piece of equipment, and haul roads.
2. Types of additional dust controls proposed for bare, exposed surfaces (chemical stabilization, synthetic cover, wind breaks, vegetative cover, etc).
3. Method of application of dust suppressant.
4. Frequency of application of dust suppressant.
5. Explain what triggers the use of a special control measure other than routine measures already in place, such as covered loads or measures covered by a permit condition (increase in opacity, high winds, citizen complaints, dry conditions, etc).
6. Explain in detail what control strategies/measures will be implemented off-hours, i.e., Saturdays/Sundays/Holidays, as well as 6 PM to 6 AM each day.

Description of Fugitive Dust Control Off-site

Prevent, to the maximum extent possible, deposition of materials, which may create fugitive dust on public and private paved roads in compliance with R307-309-5, 6, 7.

1. Types of emission controls initiated by your operation that are in place “off” property (application of water, covered loads, sweeping roads, vehicle cleaning, etc.).

2. Proposed remedial controls that will be initiated promptly if materials, which may create fugitive dust, are deposited on public and private paved roads.

Submit the Dust Control Plan to:

Executive Secretary
Utah Air Quality Board
POB 144820
15 North 1950 West
Salt Lake City, Utah 84114-4820

Phone: (801) 536-4000
FAX: (801) 536-4099

Fugitive Dust Control Plan Violation Report

When a source is found in violation of R307-309-3 or in violation of the Fugitive Dust Control Plan, the source must submit a report to the Executive Secretary within 15 days after receiving a Notice of Violation. The report must include the following information:

1. Name and address of dust source.
2. Time and duration of dust episode.
3. Meteorological conditions during the dust episode.
4. Total number and type of fugitive dust activities and dust producing equipment within each operation boundary. If no change has occurred from the existing dust control plan, the source should state that the activity/equipment is the same.
5. Fugitive dust activities or dust producing equipment that caused a violation of R-307-309-3 or the source's dust control plan.
6. Reasons for failing to control dust from the dust generating activity or equipment.
7. New and/or additional fugitive dust control strategies necessary to achieve compliance with R307-309-3, 4, 5, 6, or 7.
8. If it can not be demonstrated that the current approved Dust Control Plan can result in compliance with R307-309-3 through 7, the Dust Control Plan must be revised so as to demonstrate compliance with 307-309-3 through 7. Within 30 days of receiving a fugitive dust Notice of Violation, the source must submit the revised Plan to the Executive Secretary for review and approval.

Submit the Dust Control Plan to:

Executive Secretary	Phone: (801) 536-4000
Utah Air Quality Board	FAX: (801) 536-4099
POB 144820	
15 North 1950 West	
Salt Lake City, Utah 84114-4820	

Attachments: DFCM Form FDR R-307-309, Rule 307-309

Page 7 of 7

CONTRACTOR'S AGREEMENT

FOR:

THIS CONTRACTOR'S AGREEMENT, made and entered into this ____ day of _____, 20__, by and between the DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT, hereinafter referred to as "DFCM", and _____, incorporated in the State of _____ and authorized to do business in the State of Utah, hereinafter referred to as "Contractor", whose address is _____.

WITNESSETH: WHEREAS, DFCM intends to have Work performed at _____
_____.

WHEREAS, Contractor agrees to perform the Work for the sum stated herein.

NOW, THEREFORE, DFCM and Contractor for the consideration provided in this Contractor's Agreement, agree as follows:

ARTICLE 1. SCOPE OF WORK. The Work to be performed shall be in accordance with the Contract Documents prepared by _____ and entitled "_____
_____."

The DFCM General Conditions ("General Conditions") dated May 25, 2005 on file at the office of DFCM and available on the DFCM website, are hereby incorporated by reference as part of this Agreement and are included in the specifications for this Project. All terms used in this Contractor's Agreement shall be as defined in the Contract Documents, and in particular, the General Conditions.

The Contractor Agrees to furnish labor, materials and equipment to complete the Work as required in the Contract Documents which are hereby incorporated by reference. It is understood and agreed by the parties hereto that all Work shall be performed as required in the Contract Documents and shall be subject to inspection and approval of DFCM or its authorized representative. The relationship of the Contractor to the DFCM hereunder is that of an independent Contractor.

ARTICLE 2. CONTRACT SUM. The DFCM agrees to pay and the Contractor agrees to accept in full performance of this Contractor's Agreement, the sum of _____
_____ DOLLARS AND NO CENTS
(\$_____.00), which is the base bid, and which sum also includes the cost of a 100%

CONTRACTOR'S AGREEMENT
PAGE NO. 2

Performance Bond and a 100% Payment Bond as well as all insurance requirements of the Contractor. Said bonds have already been posted by the Contractor pursuant to State law. The required proof of insurance certificates have been delivered to DFCM in accordance with the General Conditions before the execution of this Contractor's Agreement.

ARTICLE 3. TIME OF COMPLETION AND DELAY REMEDY. The Work shall be Substantially Complete within _____ (____) calendar days after the date of the Notice to Proceed. Contractor agrees to pay liquidated damages in the amount of \$_____ per day for each day after expiration of the Contract Time until the Contractor achieves Substantial Completion in accordance with the Contract Documents, if Contractor's delay makes the damages applicable. The provision for liquidated damages is: (a) to compensate the DFCM for delay only; (b) is provided for herein because actual damages can not be readily ascertained at the time of execution of this Contractor's Agreement; (c) is not a penalty; and (d) shall not prevent the DFCM from maintaining Claims for other non-delay damages, such as costs to complete or remedy defective Work.

No action shall be maintained by the Contractor, including its or Subcontractor or suppliers at any tier, against the DFCM or State of Utah for damages or other claims due to losses attributable to hindrances or delays from any cause whatsoever, including acts and omissions of the DFCM or its officers, employees or agents, except as expressly provided in the General Conditions. The Contractor may receive a written extension of time, signed by the DFCM, in which to complete the Work under this Contractor's Agreement in accordance with the General Conditions.

ARTICLE 4. CONTRACT DOCUMENTS. The Contract Documents consist of this Contractor's Agreement, the Conditions of the Contract (DFCM General Conditions, Supplementary and other Conditions), the Drawings, Specifications, Addenda and Modifications. The Contract Documents shall also include the bidding documents, including the Notice to Contractors, Instructions to Bidders/Proposers and the Bid/Proposal, to the extent not in conflict therewith and other documents and oral presentations that are documented as an attachment to the contract.

All such documents are hereby incorporated by reference herein. Any reference in this Contractor's Agreement to certain provisions of the Contract Documents shall in no way be construed as to lessen the importance or applicability of any other provisions of the Contract Documents.

ARTICLE 5. PAYMENT. The DFCM agrees to pay the Contractor from time to time as the Work progresses, but not more than once each month after the date of Notice to Proceed, and only upon Certificate of the A/E for Work performed during the preceding calendar month, ninety-five percent (95%) of the value of the labor performed and ninety-five percent (95%) of the value of materials furnished in place or on the site. The Contractor agrees to furnish to the DFCM invoices for materials

CONTRACTOR'S AGREEMENT
PAGE NO. 3

purchased and on the site but not installed, for which the Contractor requests payment and agrees to safeguard and protect such equipment or materials and is responsible for safekeeping thereof and if such be stolen, lost or destroyed, to replace same.

Such evidence of labor performed and materials furnished as the DFCM may reasonably require shall be supplied by the Contractor at the time of request for Certificate of Payment on account. Materials for which payment has been made cannot be removed from the job site without DFCM's written approval. Five percent (5%) of the earned amount shall be retained from each monthly payment. The retainage, including any additional retainage imposed and the release of any retainage, shall be in accordance with UCA 13-8-5 as amended. Contractor shall also comply with the requirements of UCA 13-8-5, including restrictions of retainage regarding subcontractors and the distribution of interest earned on the retention proceeds. The DFCM shall not be responsible for enforcing the Contractor's obligations under State law in fulfilling the retention law requirements with subcontractors at any tier.

ARTICLE 6. INDEBTEDNESS. Before final payment is made, the Contractor must submit evidence satisfactory to the DFCM that all payrolls, materials bills, subcontracts at any tier and outstanding indebtedness in connection with the Work have been properly paid. Final Payment will be made after receipt of said evidence, final acceptance of the Work by the DFCM as well as compliance with the applicable provisions of the General Conditions.

Contractor shall respond immediately to any inquiry in writing by DFCM as to any concern of financial responsibility and DFCM reserves the right to request any waivers, releases or bonds from Contractor in regard to any rights of Subcontractors (including suppliers) at any tier or any third parties prior to any payment by DFCM to Contractor.

ARTICLE 7. ADDITIONAL WORK. It is understood and agreed by the parties hereto that no money will be paid to the Contractor for additional labor or materials furnished unless a new contract in writing or a Modification hereof in accordance with the General Conditions and the Contract Documents for such additional labor or materials has been executed. The DFCM specifically reserves the right to modify or amend this Contractor's Agreement and the total sum due hereunder either by enlarging or restricting the scope of the Work.

ARTICLE 8. INSPECTIONS. The Work shall be inspected for acceptance in accordance with the General Conditions.

ARTICLE 9. DISPUTES. Any dispute, PRE or Claim between the parties shall be subject to the provisions of Article 7 of the General Conditions. DFCM reserves all rights to pursue its rights and remedies as provided in the General Conditions.

ARTICLE 10. TERMINATION, SUSPENSION OR ABANDONMENT. This Contractor's Agreement may be terminated, suspended or abandoned in accordance with the General Conditions.

ARTICLE 11. DFCM'S RIGHT TO WITHHOLD CERTAIN AMOUNT AND MAKE USE THEREOF. The DFCM may withhold from payment to the Contractor such amount as, in DFCM's judgment, may be necessary to pay just claims against the Contractor or Subcontractor at any tier for labor and services rendered and materials furnished in and about the Work. The DFCM may apply such withheld amounts for the payment of such claims in DFCM's discretion. In so doing, the DFCM shall be deemed the agent of Contractor and payment so made by the DFCM shall be considered as payment made under this Contractor's Agreement by the DFCM to the Contractor. DFCM shall not be liable to the Contractor for any such payment made in good faith. Such withholdings and payments may be made without prior approval of the Contractor and may be also be prior to any determination as a result of any dispute, PRE, Claim or litigation.

ARTICLE 12. INDEMNIFICATION. The Contractor shall comply with the indemnification provisions of the General Conditions.

ARTICLE 13. SUCCESSORS AND ASSIGNMENT OF CONTRACT. The DFCM and Contractor, respectively bind themselves, their partners, successors, assigns and legal representatives to the other party to this Agreement, and to partners, successors, assigns and legal representatives of such other party with respect to all covenants, provisions, rights and responsibilities of this Contractor's Agreement. The Contractor shall not assign this Contractor's Agreement without the prior written consent of the DFCM, nor shall the Contractor assign any moneys due or to become due as well as any rights under this Contractor's Agreement, without prior written consent of the DFCM.

ARTICLE 14. RELATIONSHIP OF THE PARTIES. The Contractor accepts the relationship of trust and confidence established by this Contractor's Agreement and covenants with the DFCM to cooperate with the DFCM and A/E and use the Contractor's best skill, efforts and judgment in furthering the interest of the DFCM; to furnish efficient business administration and supervision; to make best efforts to furnish at all times an adequate supply of workers and materials; and to perform the Work in the best and most expeditious and economic manner consistent with the interests of the DFCM.

ARTICLE 15. AUTHORITY TO EXECUTE AND PERFORM AGREEMENT. Contractor and DFCM each represent that the execution of this Contractor's Agreement and the performance thereunder is within their respective duly authorized powers.

ARTICLE 16. ATTORNEY FEES AND COSTS. Except as otherwise provided in the dispute resolution provisions of the General Conditions, the prevailing party shall be entitled to reasonable attorney fees and costs incurred in any action in the District Court and/or appellate body to enforce this Contractor's Agreement or recover damages or any other action as a result of a breach thereof.

CONTRACTOR'S AGREEMENT
PAGE NO. 5

IN WITNESS WHEREOF, the parties hereto have executed this Contractor's Agreement on the day and year stated hereinabove.

State of _____)
County of _____)

CONTRACTOR: _____

Signature _____ Date _____

Title: _____

Please type/print name clearly

On this ____ day of _____, 20____, personally appeared before me, _____, whose identity is personally known to me (or proved to me on the basis of satisfactory evidence) and who by me duly sworn (or affirmed), did say that he (she) is the _____ (title or office) of the firm and that said document was signed by him (her) in behalf of said firm.

(SEAL)

Notary Public

My Commission Expires _____

APPROVED AS TO AVAILABILITY
OF FUNDS:

Financial Manager, _____ Date
Division of Facilities Construction
and Management

**DIVISION OF FACILITIES
CONSTRUCTION AND MANAGEMENT**

Manager - _____ Date
Capital _____

APPROVED AS TO FORM:
ATTORNEY GENERAL
May 25, 2005
By: Alan S. Bachman
Asst Attorney General

APPROVED FOR EXPENDITURE:

Division of Finance _____ Date

PERFORMANCE BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

That _____ hereinafter referred to as the "Principal" and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____ and authorized to transact business in this State and U. S. Department of the Treasury Listed (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); hereinafter referred to as the "Surety," are held and firmly bound unto the State of Utah, hereinafter referred to as the "Obligee," in the amount of _____ DOLLARS (\$ _____) for the payment whereof, the said Principal and Surety bind themselves and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the Obligee, dated the _____ day of _____, 20____, to construct _____ in the County of _____, State of Utah, Project No. _____, for the approximate sum of _____ Dollars (\$ _____), which Contract is hereby incorporated by reference herein.

NOW, THEREFORE, the condition of this obligation is such that if the said Principal shall faithfully perform the Contract in accordance with the Contract Documents including, but not limited to, the Plans, Specifications and conditions thereof, the one year performance warranty, and the terms of the Contract as said Contract may be subject to Modifications or changes, then this obligation shall be void; otherwise it shall remain in full force and effect.

No right of action shall accrue on this bond to or for the use of any person or corporation other than the state named herein or the heirs, executors, administrators or successors of the Owner.

The parties agree that the dispute provisions provided in the Contract Documents apply and shall constitute the sole dispute procedures of the parties.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the Provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20____.

WITNESS OR ATTESTATION:

PRINCIPAL:

By: _____

(Seal)

Title: _____

WITNESS OR ATTESTATION:

SURETY:

By: _____

Attorney-in-Fact (Seal)

STATE OF _____)
) ss.
COUNTY OF _____)

On this _____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney in-fact of the above-named Surety Company and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20____.

My commission expires: _____

Resides at: _____

NOTARY PUBLIC

Agency: _____
Agent: _____
Address: _____
Phone: _____

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General

PAYMENT BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

KNOW ALL PERSONS BY THESE PRESENTS:

That _____ hereinafter referred to as the "Principal," and _____, a corporation organized and existing under the laws of the State of _____ authorized to do business in this State and U. S. Department of the Treasury Listed (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); with its principal office in the City of _____, hereinafter referred to as the "Surety," are held and firmly bound unto the State of Utah hereinafter referred to as the "Obligee," in the amount of _____ Dollars (\$ _____) for the payment whereof, the said Principal and Surety bind themselves and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the Obligee, dated the _____ day of _____, 20____, to construct _____ in the County of _____, State of Utah, Project No. _____ for the approximate sum of _____ Dollars (\$ _____), which contract is hereby incorporated by reference herein.

NOW, THEREFORE, the condition of this obligation is such that if the said Principal shall pay all claimants supplying labor or materials to Principal or Principal's Subcontractors in compliance with the provisions of Title 63, Chapter 56, of Utah Code Annotated, 1953, as amended, and in the prosecution of the Work provided for in said Contract, then, this obligation shall be void; otherwise it shall remain in full force and effect.

That said Surety to this Bond, for value received, hereby stipulates and agrees that no changes, extensions of time, alterations or additions to the terms of the Contract or to the Work to be performed thereunder, or the specifications or drawings accompanying same shall in any way affect its obligation on this Bond, and does hereby waive notice of any such changes, extensions of time, alterations or additions to the terms of the Contract or to the Work or to the specifications or drawings and agrees that they shall become part of the Contract Documents.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20____.

WITNESS OR ATTESTATION:

PRINCIPAL:

By: _____ (Seal)

Title: _____

WITNESS OR ATTESTATION:

SURETY:

By: _____ Attorney-in-Fact (Seal)

STATE OF _____)
) ss.
COUNTY OF _____)

On this _____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney-in-fact of the above-named Surety Company, and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20____.

My commission expires: _____

Resides at: _____

NOTARY PUBLIC

Agency: _____
Agent: _____
Address: _____
Phone: _____

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES
Division of Facilities Construction and Management

DFCM

CHANGE ORDER # _____

CONTRACTOR: _____

AGENCY OR INSTITUTION: _____

PROJECT NAME: _____

PROJECT NUMBER: _____

CONTRACT NUMBER: _____

ARCHITECT: _____

DATE: _____

CONSTRUCTION CHANGE DIRECTIVE NO.	PROPOSAL REQUEST NO.	AMOUNT		DAYS	
		INCREASE	DECREASE	INCREASE	DECREASE

	Amount	Days	Date
ORIGINAL CONTRACT			
TOTAL PREVIOUS CHANGE ORDERS			
TOTAL THIS CHANGE ORDER			
ADJUSTED CONTRACT			

DFCM and Contractor agree that the terms, contract sum, scope of the Work and time specified in this Change Order shall constitute the full accord and satisfaction, and complete adjustment to the Contract and includes all direct and indirect costs and effects related to, incidental to, and/or reasonably implied from such change in the contract terms, sum, scope of the Work and time.

Contractor: _____ Date _____

Architect/Engineer: _____ Date _____

Agency or Institution: _____ Date _____

DFCM: _____ Date _____

Funding Verification: _____ Date _____



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management

DFCM

CERTIFICATE OF SUBSTANTIAL COMPLETION

PROJECT _____ PROJECT NO: _____

AGENCY/INSTITUTION _____

AREA ACCEPTED _____

The Work performed under the subject Contract has been reviewed on this date and found to be Substantially Completed as defined in the General Conditions; including that the construction is sufficiently completed in accordance with the Contract Documents, as modified by any change orders agreed to by the parties, so that the State of Utah can occupy the Project or specified area of the Project for the use for which it is intended.

The DFCM - (Owner) accepts the Project or specified area of the Project as Substantially Complete and will assume full possession of the Project or specified area of the Project at _____ (time) on _____ (date).

The DFCM accepts the Project for occupancy and agrees to assume full responsibility for maintenance and operation, including utilities and insurance, of the Project subject to the itemized responsibilities and/or exceptions noted below:

The Owner acknowledges receipt of the following closeout and transition materials:

☐ Record Drawings ☐ O & M Manuals ☐ Warranty Documents ☐ Completion of Training Requirements

A list of items to be completed or corrected (Punch List) is attached hereto. The failure to include an item on it does not alter the responsibility of the Contractor to complete all the Work in accordance with the Contract Documents, including authorized changes thereof. The amount of _____. (Twice the value of the punch list work) shall be retained to assure the completion of the punch list work.

The Contractor shall complete or correct the Work on the list of (Punch List) items appended hereto within _____ calendar days from the above date of issuance of this Certificate. If the list of items is not completed within the time allotted the Owner has the right to be compensated for the delays and/or complete the work with the help of independent contractor at the expense of the retained project funds. If the retained project funds are insufficient to cover the delay/completion damages, the Owner shall be promptly reimbursed for the balance of the funds needed to compensate the Owner.

CONTRACTOR (include name of firm) by: _____
(Signature) DATE

A/E (include name of firm) by: _____
(Signature) DATE

USING INSTITUTION OR AGENCY by: _____
(Signature) DATE

DFCM (Owner) by: _____
(Signature) DATE

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SECTION 02100 - SITE PREPARATION AND EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section cover furnishing all material, equipment, accessories, tools, services, transportation, labor and supervision required earthwork activities related to site preparation and installation of structures, including:

1. Disposal of Waste Materials
2. Excavation and Trenching
3. Structural Backfill and Other Fill
4. Site Grading
5. Embankments
6. Borrow
7. De-watering
8. Grading Maintenance and Repair
9. Base Under Asphalt Pavement

B. Definitions

1. Backfilling: Material placed in an excavation for structures, embankments, or trenches for underground utilities.
2. Borrow: Earth materials obtained from sources other than excavations or stockpiles within the area to be graded by Contractor.
3. Clearing: The removal of trees, shrubs, and other vegetation above the existing grade surface.
4. Demolition: The removal of improvements without regard to class and type of construction or material.
5. Excavation: Material removed (cut) below the elevation of the stripped ground surface, or material removed for trenching or structure foundations.
6. Structural Fill: Material placed above the elevation of the original (existing) ground surface after stripping and under and at a 45 degree angle to structures or pavement.
7. Grubbing: The removal of roots, shrubs, and other vegetation to a depth below the ground surface.
8. Stabilize: Placement of sod, seed, riprap or crushed rock in order to prevent the erosion of Soil.
9. Stripping: Excavation of an overlying layer of material to expose material of a different type, use, or class.
10. Subgrade: The surface layer of earth on which structures, pavements, rock surfacing, or other surfacing materials, except topsoil, are to be placed.
11. Topsoil: The final surface layer of earth material intended to support vegetation.
12. Non-Structural Fill: Material placed above the elevation of the original (existing) ground surface after stripping that is not structural fill.

C. Geotechnical Investigations

1. Work on this project shall conform to any geotechnical investigation reports pertaining to the site that are made available to the Contractor by the Owner or Engineer. Situations where a report conflicts with direction this Section it shall be brought to the attention of the Engineer for resolution.

1.2 QUALITY ASSURANCE

A. Applicable Standards

1. American Society of State Highway and Transportation Officials (AASHTO):
 - (a) M80 - Coarse Aggregate for Portland Cement Concrete

- (b) T99 - The Moisture-Density Relations of Soils Using a 5.5-Pound (2.5-kg) Rammer and a 12-Inch (305-mm) Drop
 - (c) T104 - Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
2. American Society for Testing and Materials (ASTM):
- (a) C131 - Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - (b) DI556 - Density of Soil In Place by Sand Cone Method
 - (c) D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
 - (d) D2167 - Test for Density and Unit Weight of Soil In-Place by Rubber Balloon Method
 - (e) D2922 - Test Method for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)
 - (f) D3017 - Test Method for Moisture Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth)
 - (g) D 4253 - Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
 - (h) D4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
 - (i) D4313 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
 - (j) D4546 - One-Dimensional Swell/Settlement Potential of Cohesive Soils
- B. Sampling and Testing
- 1. Tests to determine conformance with requirements of this Section for quality, such as compaction requirements, and properties of Contractor secured materials, including borrow materials (both on or off site) proposed for use, shall be performed by an independent, commercial laboratory provided by the Owner. The Contractor shall pay for all re-work testing for material that failed.
 - 2. Copies of all reports and certificates, regarding tests and inspection of equipment, materials and completed work, shall be distributed by the Owner. The Contractor shall furnish specific schedules of his work to the Owner for sampling purposes.

1.3 CONTRACTOR SUBMITTALS

- A. "Certifications of Compliance with this Specification Section" from the manufacturer to the Engineer for materials used in construction.
- B. Descriptions, properties, test results and sieve analysis, as applicable, for all materials, including materials to be used "as equal" to materials specified. A commitment shall not be made by the Contractor to procure or place any material until approved by the Engineer.
- C. Construction schedule to the Engineer and schedule updates as requested by the Engineer.

1.4 JOB CONDITIONS

- A. Lines and grades shall be as indicated on the drawings. Contractor shall use benchmarks, reference points and any other points that have to be established for layout and to construct the work properly.
- B. Carefully maintain all benchmarks and monuments and replace as directed if disturbed or destroyed at no additional cost to Owner.

C. Disposition of Existing Facilities, Structures and Property

1. Adequately protect from damage all existing utilities, structures and property and remove or relocate only as indicated, specified or as directed by Owner.
2. It shall be the Contractor's responsibility to have existing underground utilities located and verified prior to earth moving activities.
3. Report inactive and abandoned utilities encountered in excavating and grading operations. Remove, plug, or cap as directed by Owner.

D. Environmental Protection

1. The Contractor shall employ construction methods and techniques that will result in the least detrimental impact upon the environment and comply with requirements of all regulatory agencies. Requirements for this shall be as indicated on the drawings and other contract documents and as directed by the Engineer at no additional cost to the Owner. They include, but are not limited to, the following:
 - (a) Silt fences or straw bales shall be placed as required to protect the surrounding areas from actions on the project.
 - (b) During dry and windy weather watering trucks shall be used to lessen wind erosion and air born dust.
 - (c) Contractor shall repair ruts before leaving the area. At the conclusion of each working day the site shall be left in a condition to prevent soil erosion due to a possible rainfall event.
 - (d) Areas that are damaged by construction activities shall be regraded to their original condition and resurfaced.
 - (e) Care should be taken to avoid. Areas polluted from oil or fuel spills or other materials during construction shall be cleaned and restored to their original condition.
 - (f) If items or areas of possible archaeological interest are uncovered during construction, Contractor shall notify Owner immediately.
 - (g) Removal of trees and other vegetation shall be the minimum required to provide the clearing grading indicated on the drawings and this Section.

E. Blasting

1. Blasting is not to be used unless approved by the Owner unforeseen situations occur during construction. The Contractor shall prevent over blasting and be responsible for all damage caused by his blasting operations.

PART 2 - MATERIALS

2.1 GENERAL

- A. The Contractor shall furnish and install all earth material, structural fill, finish fill, gravel, rock, and pavement base necessary for project completion.
- B. Obtain materials for embankment construction in the following order of priority:
 1. From on-site excavation.
 2. From borrow areas secured by the Contractor

2.2 FILL

A. Trench Bedding

1. Sand or gravel with 3/8 inch maximum diameter and not over 10 percent passing the #200 sieve.

B. Structural fill

1. Material from excavations and borrow areas that is free of debris, roots, organic matter, refuse, ashes, cinders, frozen earth, clay and which is free of rock with any dimension greater than four inches for general use and two inches for use in trenches. The maximum amount of material that is retained on the No. 200 sieve shall be 10 percent. The liquid limit shall not exceed 40 and the plastic index shall not exceed 25 in accordance with ASTM D4313. The material shall not be excessively wet and shall be approved by the Engineer.

C. Lean mix concrete

1. Concrete with a 1500 psi 28-day minimum compressive strength.

D. Rock (Gravel)

1. Uniformly graded crushed rock "pea gravel" conforming to ASTM C33-86 with a size between 1/2 inch and 1/8 inch.

E. Base

1. Selected granular material with 3/4 inch maximum size and conforming to Utah Department of Transportation (UDOT) requirements.

PART 3 - EXECUTION

3.1 CLEARING AND GRUBBING

A. General

1. This work shall consist of clearing, grubbing, removing and disposing of all trees, large brush and debris within the limits occupied by roadways, parking areas, structures, easement areas and other areas indicated on the drawings. This work shall also include the preservation from injury or defacement of all trees, vegetation and objects other than those designated for clearing or those outside of the clearing lines. Clearing lines shall be 10 feet beyond the limits of construction. This includes all areas of cut and fill for roadways, parking areas, building areas and other areas as indicated on the drawings or directed by the Engineer.
2. The ground between the clearing lines shall be cleared of all trees, stumps, brush and other objectionable material. All trees, stumps, roots, etc. shall be cut off, excavated, or removed to a depth of not less than 2 feet below the subgrade or embankment slopes. All excavations made by the removal of trees, stumps, etc. shall be filled with structural fill and conform to the surrounding grade.
3. Clearing and grubbing activities shall be completed immediately prior to grading to minimize disturbance at the site and limit disturbance to areas scheduled for grading and earthwork activities. Contractor shall obtain a "blue stake" marking from local utilities before digging.
4. The top six inches of existing surface material and additional material, as determined by the Engineer, shall be excavated and removed off site.
5. Materials not to be used, reused, or with specific instructions on the project, including organic and clear and grubbing material, shall be removed from work area as excavated. Dispose of this waste material legally, off the job site, at a location determined for by the Contractor, at no additional cost to Owner.

3.2 EXCAVATION AND TRENCHING

A. General

1. Excavate all materials found within the limits for excavation.
2. Perform excavation by any recognized method of good practice to complete the job in the most expeditious manner in conformance with specified requirements.
3. Take precautions to ensure no damage to existing facilities or equipment, or other work.
4. Rock encountered shall be handled at no additional cost to Owner.
5. Where previously placed fill material is encountered during excavation, the full depth of the existing fill shall be removed within 10 lateral feet of structures or roadway for replacement with structural fill.
6. Rock encountered during excavation shall be removed with pneumatic hammers or heavy equipment where possible. See Para. 1.4.E for blasting requirements.
7. Where directed or where required for the protection of workmen or public safety, substantial barricades shall be erected and maintained, and warning flares and lights shall be installed and maintained.
8. Where required to prevent caving and damage to existing building foundations, utilities, equipment or other installations and for the protection of workmen, excavations shall be sheeted and braced in accordance with OSHA requirements. All sheeting and bracing shall be removed during the backfill operations unless ordered left in place. Personnel access to below grade areas shall be carried out in such a manner that personnel safety is ensured.
9. Excavation of existing pavement and concrete shall be saw cut at sections that are to remain.
10. The subgrade tolerance shall be minus 0.1 foot plus 0.0 foot.
11. Surplus earth and materials not suitable for the work shall be removed from the site in a prompt manner and disposed of legally in accordance with all federal, state and local requirements.

B. Structures

1. Make excavation area adequate to permit efficient placement and removal of forms and to provide minimum clearances for backfilling around structure as required for compaction.
2. Trim to neat lines where details call for concrete to be deposited against earth.
3. Excavate by hand in areas where space and access will not permit use of machines.
4. Where rock is encountered in a portion of a structural excavation along with adjacent non-rock material under the same structural excavation, remove rock to a minimum of 18 inches below the elevation of the structure's footing and replace with structural fill.
5. Restore over excavation as follows at no extra cost to Owner:
 - (a) For mat or slab foundations place structural fill.
 - (b) For drilled shafts place concrete.

C. Trenches

1. Side walls shall be vertical or slope within specified trench width limitations.
2. Excavate without undercutting.
3. Remove material required for alignment and elevation with a minimum depth of excavation for utility installation.
4. Remove rock fragments and materials disturbed during excavation or dislodged from trench walls.
5. Trench shall have a minimum width permitting satisfactory work clearances and sufficient compaction of bedding and backfill materials.
6. Correct over excavated areas with fill as directed by the Engineer at no additional cost to Owner. Perform trenching in embankment areas after compacted embankment has reached an elevation of not less than one foot above the top of the pipe.

D. De-watering

1. Control grading around excavations to prevent surface water from flowing into excavation areas.

2. Drain or pump as required to continually maintain, including days not normally worked, all excavations free of water or mud from any source, and discharge to approved drains or channels. Begin when water first appears and continue as required to keep excavation free of standing water during entire time excavation is open.
3. Remove unsuitable wet subgrade materials and replace with approved structural fill as directed by Engineer at no additional cost to Owner.

3.3 EMBANKMENT, BASE MATERIAL AND OTHER BACKFILL

A. General

1. The construction of embankments, structural fill and other fill shall consist of obtaining suitable materials and placing these materials in compacted lifts.
2. Backfill for trenches shall be placed with structural fill in or gravel as indicated on the drawings accordance with this Section.

B. Placement

1. Material placed under and adjacent to pavement, structures and where otherwise designated shall be structural fill. Adjacent structural fill placement shall include material at a 45 degree angle from pavement surfaces and bottom of structure footings.
2. Place to the contours and elevations indicated on the drawings in 8-inch maximum loose layers.
3. If the slope bounding the embankment area is steeper than six horizontal to one vertical, step existing grade prior to placing material.
4. Perform wetting or drying of material as required to obtain specified density. The moisture content at time of placement shall be within the following specified range:
 - (a) Lower Limit: 2 percent below optimum moisture content.
 - (b) Upper Limit: 3 percent above optimum moisture content.
 - (c) Moisture content shall conform with ASTM D1557.
5. Do not place snow, ice or frozen earth in embankments and do not place structural fill on frozen surfaces.
6. Prior to constructing embankment, the ground surface shall be proof rolled with a medium weight roller or other suitable equipment. Contractor shall identify the location of soft or yielding materials for replacement.
7. Place embankment material only on ground surfaces which conforms to the following:
 - (a) Scarified to 6 inches deep prior to placement of first lift.
 - (b) Compacted prior to placement of second or succeeding lifts.
 - (c) Wetted or dried as required to obtain correct moisture content.
 - (d) Soft spots are over excavated, filled and compacted as specified.
 - (e) Approved by Owner.
8. All slopes and embankments shall be constructed one foot wider than indicated and then dressed to final grade.
9. Base material shall be 12 inches thick after compaction unless indicated otherwise on the drawings.

C. Compaction

1. Structural fill, base, and bedding shall be compacted to 95 percent of the maximum dry density as determined by ASTM D1557. Non-structural fill material shall be compacted to 85 percent of the maximum dry density. Rock (gravel) shall be compacted with two passes of a vibratory compactor at 90 degrees or 180 degrees to each other. Asphalt pavement shall be compacted to conform to Section 02500 requirements.
2. Obtain compaction specified by normal methods and equipment.

3. Embankment failing to meet specified densities shall be removed or scarified and re-compacted to meet specified densities.
4. Exercise caution in the use of heavy equipment in areas adjacent to existing structures.

3.4 QUALITY CONTROL

A. Field Testing

1. The method of in-place compaction testing shall be in accordance with ASTM D2167, D2922, or D3017 as approved by the Engineer.
2. Frequency of compaction (density and moisture content) testing shall be as follows:
 - (a) At least one test for every lift or 1000 cubic yards, whichever occurs first, of material placed in a large embankment.
 - (b) At least one test every 100 feet per lift along access road.
 - (c) At least- one test for every 200 cubic yards of material placed in trenches or around structures.
 - (d) At least one test for every shift of compaction operation on a mass embankment.
 - (e) At least one test when Owner suspects the quality of moisture control or effectiveness of compaction.
3. The Owner shall provide the testing agency.
4. The contractor will be responsible for arranging and carrying out the compaction tests required for the different types of construction at no cost to the Owner. The compaction test results will be submitted to the Engineer.

3.5 ROCK FILL

- A. The material shall be placed in horizontal layers not more than 8 inches thick on undisturbed subgrade or concrete and compacted to not less than 70 percent relative density as determined by ASTM D4253-83 and D4254-83. Compaction shall be performed with vibrating mechanical compactors.

3.6 SITE GRADING

A. Rough Grading

1. Excavate, place embankments and grade to the approximate subgrade elevations and contours indicated on the drawings.

B. Finish Grading

1. Grade and compact all areas within the project, including excavated and filled sections, and adjacent transition areas reasonably smooth and free from irregular surface changes.
2. Degree of finish shall be that ordinarily obtained from blade grader or scraper operations, except as otherwise specified.
3. Finish all ditches and swales to drain readily. They shall be in a "V" shape and excavated at least 1 foot deep and 3 feet across the top unless shown otherwise on the drawings.
4. Provide rounded surfaces at top and bottom of banks and at other breaks in grade.

3.7 ROADWAYS AND PARKING AREAS

A. Placement

1. Roadways and parking areas shown on the drawings under paved surfaces shall have 12 inches of base, unless indicated otherwise. Asphalt paving shall conform to Section 02500.
2. The subgrade shall be sloped 1/4 inch per foot minimum and provide adequate drainage.

3. Finished subgrades for roads and surfaced areas shall not be lower than indicated, nor higher than 0.1 foot above that indicated.

3.8 SURVEYING

A. Description

1. Unless otherwise specified in the scope of work for this project, the Owner shall provide the survey control and a benchmark elevation required for control of layout and construction of the project. The Contractor shall provide additional surveying work required for completion of the project.
2. Contractor, upon Engineer request, shall furnish survey notes, quantity calculations and plotted cross-sections (if used) to the Engineer for review and approval for survey work performed.

B. Surveyor Qualifications

1. All surveying work shall be performed under the direction of a Professional Land Surveyor or Professional Civil Engineer licensed to practice in the State of Utah.

3.9 MAINTENANCE AND REPAIR

A. Maintenance

1. Protect newly graded areas from actions of the elements.
2. Settling or erosion shall be filled, compacted, repaired and grades reestablished to elevations, contours, and slopes indicated.

B. Correction of Settlement

1. Contractor is responsible for correcting any excessive settlement as directed by the Owner, for the specific areas of embankments or backfill and for damage created thereby within one year after acceptance of the Work.
2. Make repairs within 10 days from notification by Owner of embankment or backfill settlement and resulting damage.
3. Make arrangements with Owner for access to the site for purposes of repair.

3.10 WORK BEYOND SCOPE

- A. The Contractor shall be compensated as “extra work” for work completed that is beyond the scope of work included on the Drawings and other contract documents. This “extra work” shall be completed as directed by the Construction Manager for work initiated by the Owner as required for the project, and not as over excavation or other work created by the Contractor.

END OF SECTION 02100

SECTION 02500 - SITE PAVING

PART 1 - GENERAL

1.1 SCOPE

- A. This Section covers furnishing all material equipment, accessories, tools, services, transportation, labor and supervision required for the supply and placement of asphalt pavement.

1.2 SUMMARY

A. Included in this Section

- 1. Hot mixed asphalt paving over prepared base.
- 2. Proof rolling of prepared base.
- 3. Tack and prime coats and herbicide treatment.
- 4. Pavement marking.
- 5. Wheel Stops

B. Work not included in this Section

- 1. Prepared base and saw cutting of existing pavement edges are specified in Section 02100.

1.3 CONTRACTOR SUBMITTALS

- A. Descriptions, properties, test results and sieve analysis, as applicable, for all materials to be used to the Engineer. A commitment to purchase materials or the use of materials shall not be made prior to approval by the Engineer.
- B. Material Certificates signed by material producer and Contractor to the Engineer, certifying that each material item complies with or exceeds specified requirements.
- C. Pavement marking plan indicating access lanes, line color, dedicated handicapped spaces with international graphics symbol, wheel stops and defined parking spaces to the Engineer.
- D. Construction schedule to the Engineer and schedule updates as requested by the Engineer.

1.4 SITE CONDITIONS

- A. Apply prime and tack coats when ambient temperature is above 50 deg F and when temperature has not been below 35 deg F for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.
- B. Place hot-mixed asphalt surface course when atmospheric temperature is above 40 deg F and rising and when the base is dry. Base course may be placed when air temperature is above 30 deg F and rising.
- C. Establish and maintain required grade lines and elevations.

PART 2 - MATERIALS

2.1 GENERAL

- A. Use locally available materials and gradations that exhibit a satisfactory record of previous installations.

2.2 COARSE AGGREGATE

- A. Sound, angular crushed stone, crushed gravel, or properly cured crushed blast furnace slag, complying with ASTM D 692-88.
- B. Wear less than 40 percent per ASTM C131.

2.3 FINE AGGREGATE

- A. Sharp-edged natural sand or sand prepared from stone, properly cured blast furnace slag, gravel, or combinations thereof, complying with ASTM D 1073.
- B. Wear less than 40 percent per ASTM C131.

2.4 MINERAL FILLER

- A. Rock or slag dust, hydraulic cement, or other inert material complying with ASTM D 242.

2.5 ASPHALT CEMENT

- A. Complying with ASTM D 3381 for viscosity-graded material or ASTM D 946 for penetration-graded material.

2.6 PRIME COAT

- A. Cut-back asphalt type complying with ASTM D 2027; MC-30, MC-70 or MC-250.

2.7 TACK COAT

- A. Emulsified asphalt complying with ASTM D 977, Grade SS-1H, or ASTM D2397, Grade CSS-1H.

2.8 HERBICIDE TREATMENT

- A. Commercial chemical for weed control, registered by Environmental Protection Agency. Provide granular, liquid, or wettable powder form complying with requirements of the project.
- B. Acceptable manufacturers are as follows:
 - 1. Ciba-Geigy Corp.
 - 2. Dow Chemical U.S.A.
 - 3. E.I. Du Pont de Nemours & Co., Inc.
 - 4. FMC Corp.
 - 5. Thompson-Hayward Chemical Co.
 - 6. U.S. Borax and Chemical Corp.

2.9 LANE MARKING PAINT

- B. Factory mixed, quick drying and non-bleeding latex base paint conforming to Federal Standard TT-P-1952B.
- C. Approved products are as follows;
 - 1. Setfast Fast Dry Latex, TM 2136 and 2137 by Sherwin Williams

2.10 WHEEL STOPS

- D. Pre-cast reinforced concrete with a compressive strength of 2,500 psi, air-entrained and approximately 6 inches high, 9 inches wide and 7 feet long. Provide chamfered corners and drainage slots on underside.

2.11 ASPHALT PAVING MIXTURE

- A. Plant-mixed, hot asphalt aggregate paving mixture with the designed developed in accordance to Marshall Method (ASTM D1559 and ASTM D1075 – 50 blow count Marshall) to achieve optimum asphalt content as shown by test data curves of samples at ½ percent asphalt content increments. Samples shall include two above and below optimum asphalt determined.
- B. Final mix design shall meet UDOT requirements with the exception it shall meet the following criteria;
 - 1. Stability – 1200 pounds minimum
 - 2. Flow - 8 minimum, 18 maximum
 - 3. Air voids – 2 percent minimum, 4 percent maximum
 - 4. Voids in mineral aggregate – 15 percent maximum
 - 5. Asphalt cement by weight of total – 5 percent minimum
 - 6. Dry strength – 200 psi minimum
 - 7. Index of retained strength – 75 percent +/- 5 percent

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Proof roll prepared base surface to check for unstable areas and areas requiring additional compaction.
- B. Remove loose material from compacted subbase surface immediately before applying herbicide treatment or prime coat
- C. Notify Engineer of unsatisfactory conditions. Do not begin paving work until deficient base areas have been corrected and are ready to receive paving as determined by the Engineer..
- D. Apply Herbicide Treatment chemical weed control agent in all areas to be paved, unless indicated otherwise on the drawings, in strict compliance with manufacturer's recommended dosages and application instructions. Apply to compacted, dry subbase prior to application of prime coat.
- E. Apply Prime Coat at rate of 0.20 to 0.50 gal. per sq. yd., over compacted base material. Apply material to penetrate and seal, but not flood, surface. Cure and dry as long as necessary to attain penetration and evaporation of volatile.
- F. Apply Tack Coat to contact surfaces of existing asphalt concrete and Portland cement concrete surfaces abutting or projecting into hot-mixed asphalt pavement. Distribute at rate of 0.05 to 0.15 gal. per sq. yd. of surface.
- G. Allow prime and tack coats to dry until the proper condition is reached to receive paving.
- H. Exercise care in applying bituminous materials to avoid smearing of adjoining pavement surfaces. Remove and clean damaged surfaces.

3.2 PLACING PAVING MIX

- A. Place hot-mixed asphalt paving mixture on prepared surface, spread, and strike off. Spread mixture at minimum temperature of 250 deg F. Place areas inaccessible to equipment by hand. Place each course to

required grade, cross-section, and compacted thickness. Paving shall be 3 inches thick after compaction, unless otherwise shown on the drawings.

- B. Place paving mix in strips not less than 10 feet wide, unless otherwise approved by the Engineer. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course.
- C. Immediately correct surface irregularities in finish course behind paver. Remove excess material forming high spots with shovel or lute.
- D. Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining sections. Construct joints to be vertical and have same texture, density, and smoothness as other sections of hot-mixed asphalt course. Clean contact surfaces and apply tack coat.
- E. Construct asphalt curbs shown on the drawings over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust.
- F. Place asphalt curb materials to cross-section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms as soon as material has cooled.
- G. Paving thickness indicated over 3 inches shall be placed in two lifts.
- H. Paving surface adjacent to existing concrete shall be 1/8 to 1/4 inch above concrete surface.

3.3 COMPACTION (ROLLING)

- A. Begin rolling when mixture will bear roller weight without excessive displacement. Use powered equipment capable of obtaining specified density.
- B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
- C. Compact asphalt paving to 96 percent minimum. Determine percent compaction using density of test cores determined by either ASTM D1188 or ASTM D2726 divided by laboratory compacted density as determined by ASTM D1559. The maximum total air voids in the compacted paving shall be 8 percent as determined by ASTM D2041.
- D. Begin breakdown, or initial rolling, immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling, if required, with hot material. Complete breakdown rolling before mix temperature drops below 250 deg F. Complete handwork compaction concurrently with breakdown rolling.
- E. Follow breakdown rolling with second rolling as soon as possible after initial rolling. Continue second rolling until mixture has been evenly compacted. Finish rolling before mix temperature drops below 185 deg F.
- F. Surface texture and grade of hand worked areas shall match machine laid areas.
- G. Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot hot-mixed asphalt. Compact by rolling to specified surface density and smoothness.
- H. After final rolling do not permit vehicular traffic on pavement until it has cooled and hardened.
- I. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.4 TRAFFIC AND LANE MARKINGS

- A. Sweep and clean surface to eliminate loose material and dust.
- B. Do not apply traffic and lane marking paint until layout and placement have been verified with Engineer.
- C. Apply paint with mechanical equipment to produce uniform straight edges. Apply at manufacturer's recommended rates to provide minimum 8.5 mils dry thickness. Apply a test strip to asphalt paving less than three months old. If cracking or lifting develops apply paint in two 4-1/2 mils dry thickness coatings.

3.5 WHEEL STOPS

- A. Place wheel stops and secure to asphalt paving surface with not less than two 3/4 inch diameter galvanized steel dowels embedded in precast concrete at 1/3 points. Dowel shall extend 4 to 6 inches into the wheel stop and penetrate at least 2 inches into the asphalt paving.

3.6 FIELD QUALITY CONTROL

- A. Testing in-place hot-mixed asphalt paving courses for compliance with requirements for thickness, compaction and surface smoothness will be done by Owner's testing laboratory. Repair or remove and replace unacceptable paving and retest as directed by Engineer or Owner at no additional cost to the Owner.
- B. Testing of in-place compacted paving in accordance with ASTM D 3549 shall not be acceptable if exceeding any of the following allowable variations:
 - 1. Base Course (pavement thickness greater than 3 inches): Plus or minus 1/2 inch
 - 2. Surface Course: Plus 1/2 inch or minus 0 inch
- C. Paving surface smoothness shall be tested using a 10-foot straightedge applied parallel with and at right angles to the centerline of paved area. Surface areas shall be checked at intervals directed by Engineer or Owner. Paving will not be acceptable for variations exceeding the following tolerances for smoothness:
 - 1. Base Course: 1/4 inch
 - 2. Wearing Course: 3/16 inch
 - 3. Crowned Surfaces: 1/4 inch at right angle to crown.

END OF SECTION 02500

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SCOPE

- A. This Section covers furnishing all material, equipment, accessories, tools, services, transportation, labor and supervision required for the supply and installation of cast in place concrete.

1.2 CONCRETE

- A. Concrete shall be normal weight (145 pcf) ready-mixed concrete with a compressive strength (f'c) of not less than 4000 psi at 28 days unless indicated otherwise on the drawings or this Section.

1.3 ITEMS INCLUDED

- A. This specification includes the following items:
 - 1. Concrete for structures
 - 2. Reinforcement
 - 3. Formwork
 - 4. Embedded items, including anchor rods (anchor bolts)

1.4 QUALITY CONTROL

- A. All work is subject to approval by the Owner and the Engineer. Work not in compliance to the drawings or this Section shall be replaced or repaired as directed by the Engineer at not additional cost to the Owner.
- B. Materials called out on the drawings and in this Section shall be placed as specified herein and per the manufacturer's recommendations. The Contractor shall notify the Engineer of discrepancies.
- C. The descending order of priority for direction of work to the Contractor is as follows:
 - 1. Written direction from the Engineer
 - 2. Contract drawings
 - 3. Contract Specifications

1.5 SUBMITTALS

- A. Five (5) copies of the following, unless indicated otherwise, shall be submitted to the Engineer for review and approval;
 - 1. Design of concrete mixes in accordance with this Section and ACI 301, Chapter 3. List all ingredients with their description, property values and a compliance statement for Standards stated in this Section.
 - 2. Reinforcing steel and embedded items shop drawings, bar lists and bending and erection drawings. Two sets of these documents shall accompany the first load of reinforcing delivered to the job site.
 - 3. Test reports and material certifications as noted elsewhere in this Section and/or on the Drawings.
 - 4. One copy of the final reinforcing steel and embedded items shop drawings shall be forwarded to the Engineer when they are issued to the shop.
 - 5. Concrete placement procedure, cold weather concreting or hot weather protection plans when requested by the Engineer.
 - 6. Concrete curing method.
 - 7. The concrete supplier shall furnish the certification specified in Paragraph 14 of ASTM C94.
 - 8. Description and specifications for any prefabricated panel section systems to be used.

B. Substitute materials shall be submitted for use as follows;

1. The contractor shall submit five copies of the material description and its properties to the Engineer for material intended for use other than those included in this Section.
2. Substitute materials for materials included in this Section shall not be used without approval of the Engineer.

C. Material shall not be ordered nor work started that may be impacted by a submittal until the submittal is approved by the Engineer. Review time necessary for the Engineer may be requested with one week being minimum.

1.6 CODES AND STANDARDS

A. The following codes and standards of the latest revision shall be considered as part of this specification:

1. American Concrete Institute, ACI 318, Building Code Requirements for Reinforced Concrete
2. ACI 301, Specifications for Structural Concrete for Buildings
3. ACI 304, Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
4. ACI 305, Recommended Practice for Hot Weather Concreting
5. ACI 306, Recommended Practice for Cold Weather Concreting
6. ACI 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures
7. ACI 347, Recommended Practice for Concrete Formwork
8. American Society for Testing and Materials (ASTM), as noted
9. American Welding Society D12.1, Recommended Practices for Welding Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete Construction
10. Concrete Reinforcing Steel Institute (CRSI), as noted
11. International Building Code, 2003 Edition

1.7 ADDITIONAL MATERIALS

A. Materials relating to concrete indicated on the drawings that are not included in this Section shall be subject to its requirements of this Section.

1.8 SCHEDULE

A. Contractor shall submit a schedule of work to the Engineer and updates as requested by the Engineer.

PART 2 - MATERIALS

2.1 CEMENT

A. All cement shall be Portland Cement conforming to ASTM C150, Type II or III cement. All cement supplied shall be of one manufacturer.

2.2 WATER

A. Water used in mixing shall be clean and free from materials in amounts deleterious to concrete conforming to ASTM C1602, "Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete."

2.3 ADMIXTURES

- A. Chemical Admixtures shall conform to ASTM C 494, "Chemical Admixtures for Concrete." They shall maintain or improve properties of the original design mix and equal or exceed ASTM C494, Type D.
- B. Mineral:
 - 1. Fly Ash Pozzolan: Meeting the requirements of ASTM C618, Class F or C and with a loss on ignition (LOI) of 3 percent maximum.
 - 2. Silica Fume (Microsilica) - Force 10,000 by Grace
- C. Chemical:
 - 1. Chemical admixture shall not contain calcium chloride nor shall calcium chloride be used as an admixture. All chemical admixtures used shall be from the same manufacturer.
 - 2. Air Entraining Agents conforming to requirements of ASTM C260.
 - 3. Water Reducer conforming to requirements of ASTM C494, Type D.
 - 4. Water Reducer and Set Controller conforming to requirements of ASTM C494, Type D.
 - 5. High Range Water Reducer conforming to requirements of ASTM C494, Type F or G.
 - 6. Non-chloride Accelerator conforming to requirements of ASTM C494, Type C.
 - 7. Corrosion Inhibitor - MCI – 2000 by Cortec.
 - 8. Shrinkage Inhibitor conforming to requirements of ASTM C494, Type D.

2.4 AGGREGATE

- A. Fine aggregate shall conform to ASTM C33, "Concrete Aggregates."
- B. Coarse aggregate shall conform to ASTM C33, "Concrete Aggregates," with 1 inch to No. 4 size gradation.
- C. Aggregate shall have an expansion potential of less than 0.1% in accordance to AASHTO T 303 or the concrete mix shall be tested and approved by the Engineer to have an overall expansion potential of is less than 0.1% to provide against ASR mitigation.

2.5 MIX DESIGN

- A. Concrete shall meet the durability and quality requirements specified in ACI 318, Chapters 4 and 5 and conform to ASTM C94. Mix ingredients may be modified to meet the intent of the concrete mix design only after approval of the Engineer.
- B. Method of proportioning shall be in accordance with ACI 211.1, "Recommended Practice for Selecting Proportions for Normal and Heavy Weight Concrete." Mix proportioning shall not provide a 7 day compressive strength test result of concrete that is greater than the 28 day design strength.
- C. The determination of the water-cement ratio to attain the required strength shall be in accordance with ACI 301, Method 2 (For combinations of materials previously evaluated or to be established by trial mixes), and with ACI 211.1. The maximum water-cement (including pozzolan) ratio (by weight) shall be 0.4 and the minimum cement content shall be 6 sacks per cubic yard.
- D. From the test results of the aforementioned procedures, a curve shall be plotted showing relationship between the water-cement ratio and compressive strength, and the maximum water-cement ratio to be used shall be the value shown by the curve to produce the strength a minimum of 25 percent greater than the strength specified.
- E. Concrete shall be air-entrained 3.5 to 6.5 percent, except interior steel troweled surfaces shall not be air-entrained.

- F. The maximum slump of concrete shall be three inches prior to use of a water reducer and eight inches maximum with the use of a water reducer.
- G. Mixing, transporting and placing concrete shall conform to applicable portions of ACI 211, ACI 212 and ACI 304 and as specified herein.
- H. The maximum amount of cement that may be substituted with a pozzolan is 15 percent of the total design cement weight.
- I. Concrete with special properties such as self-consolidating or reduced shrinkage shall be indicated in the Drawings or this Section. Mixes for this concrete shall be designed and tested as required by the Engineer.

2.6 REINFORCEMENT

A. Reinforcing Steel (Rebar)

- 1. Reinforcing steel shall be deformed bars conforming to ASTM A615, Grade 60, or A706 for welding, unless indicated otherwise. Rebar shall be tagged with mark number and size before shipment.
- 2. Rebar shall be detailed and fabricated conforming to ACI 315.
- 3. The fabricator shall prepare complete placement drawings and bending schedules.

B. Coated Bars

- 1. Reinforcing bars shall either be galvanized or epoxy coated, as designated, where indicated on the Drawings.
- 2. Galvanized coated reinforcement shall be Class I hot dipped zinc coated after fabrication in accordance with ASTM A767. Galvanized surfaces damaged prior to placement of concrete shall be repaired in accordance with ASTM A780.
- 3. Epoxy coated reinforcement shall be coated in accordance with ASTM A775. Epoxy surfaces damaged prior to placement of concrete shall be repaired with "3M Scottcoat 306."

C. Welded Wire Fabric

- 1. Welded Wire Fabric shall conform to "Welded Steel Wire Fabric for Concrete Reinforcement" ASTM A185.

D. Steel Wire

- 1. All cold-drawn steel wire for concrete reinforcement shall be in accordance with ASTM A82.

E. Synthetic Fiber Secondary Reinforcement

- 1. Synthetic reinforcing fibers shall be collated fibrillated polypropylene, as manufactured by Fibermesh, Inc.

F. Accessories

- 1. Accessories shall conform to CRSI Manual of Standard Practice of Reinforced Concrete Construction. Include all devices necessary for proper placing, spacing, supporting, and fastening steel reinforcement in place. Accessories shall be galvanized after fabrication if underside of concrete will be exposed.

G. Concrete Squares (Precast Reinforcing Chairs)

1. Squares shall be approximately two inches square and of a thickness adequate to provide the cover for the reinforcing steel as called for on the plans. The squares shall be made using a mixture of one part Portland Cement to three parts sand (fine aggregate) and the tie wires shall be cast integrally with each square.

2.7 FORM WORK

A. Design

1. Formwork shall be designed for loads and lateral pressures outlined in Chapter 1, Recommended Practice for Concrete Formwork (ACI 347) and wind loading specified by the controlling building official. Formwork design and construction are the responsibility of the Contractor.

B. Forms

1. Forms shall be constructed of wood, steel, or other approved material. Material shall be chosen based on strength and concrete finish requirements.

2.8 EMBEDDED ITEMS

A. Anchor Rods (Bolts) and Sleeves

1. Anchor rods shall conform to ASTM F1554, Grade 36, and be furnished with two heavy hex nuts and one heavy plate washer at the exposed end and one heavy hex nut at the embedded end. Anchor rod threads shall be N.C. Class 1 fit. Welding shall be in accordance with AWS recommended practice.
2. Anchor rods 1-1/4 inches or less in diameter may be an adhesive anchor system by Hilti or Power Fasteners, or equal.

B. Miscellaneous Items

1. Curb and corner angles, frames, beams, ducts, etc. shall be fabricated with material conforming to ASTM A36 and be in accordance with "Structural and Miscellaneous Steel" Section of this Specification.
2. Embedded items shall be galvanized per ASTM A153.
3. Curb and corner angles, frames, beams, etc., shall have suitable anchors securely welded on centers not exceeding two feet. Anchors shall also be positioned within 6 inches of ends and corners. All joints, corners, splices, etc. shall be seal welded and exposed surfaces shall be ground flush. All metal surfaces shall be free from scale, rust, oil, grease and other contaminants and those surfaces not intended for contact with concrete shall be coated with a zinc chromate primer.
4. Ducts and penetrations shall be fabricated as shown on the drawings.

C. Waterstop

1. Waterstop shall be "Swellstop" by Greenstreak unless noted.

2.9 SLAB JOINTS

- A. Expansion joint "filler" shall be 1/2" thick and be in accordance to ASTM D1751 for bituminous type or ASTM D1752 or ASTM D2628 for non-bituminous type.
- B. Sealant for control and expansion joints shall be Sikaflex-2c by Sika conforming to ASTM D920. Sealant used in expansion joints requiring backer rods shall be a non-priming urethane sealant conforming to ASTM C 920.

- C. Backer rod for expansion joints shall be 1/8 inch larger in diameter than the joint width, compressible and conform to recommendations of the sealant manufacturer.

2.10 ASSOCIATED PRODUCTS

A. Subsurface Covering (Vapor Barrier)

- 1. Polyethylene sheeting 6 mil (0.006") thick natural clear conforming to commercial standard CS 238 or ASTM D 2103.

B. Bonding Agent

- 1. Bonding agent for interface surface of new concrete with existing shall be "Weld-Crete" by Larsen Products Corp.

C. Evaporation Retardant

- 1. Confilm by ChemRex Inc.
- 2. E-Con by L&M Construction Chemicals
- 3. SureFilm J-74 by Dayton Superior

D. Curing and Curing/Sealing Compounds

- 1. Curing compounds shall be curing/sealing compounds conforming to ASTM C309 with 30 percent solids minimum.
 - a. Safe Cure & Seal 30 (J-19) by Dayton Superior

E. Abrasive Aggregate

- 1. Aggressive aggregate for non-slip surfaces shall consist of not less than 55 percent aluminum-oxide or silicon-carbide abrasive ceramically bonded to form a porous homogeneous material which bonds with Portland Cement and does not affect the compressive strength of the concrete. The aggregate shall have an abrasive hardness of not less than 40 in accordance to the wear resistance test in the National Bureau of Standards Report "BMS 98."

F. Colored Concrete

- 1. One pound of RD-3097 Red Oxide Color by C. K. Williams and Company shall be added to each cubic yard of colored concrete.

G. Floor Hardener

- 1. Floor hardener shall be non-metallic "Hard Top" by Symons Corporation

PART 3 - EXECUTION

3.1 PREPARATION

- A. In no case shall concrete be placed on muddy, spongy, or frozen subgrade and all wood scraps and debris shall be removed.

- B. Areas where concrete is to be placed shall be thoroughly cleaned to ensure proper placement and bonding. Existing surfaces of concrete to come in contact with new concrete shall be roughened to have a 1/4" profile minimum.
- C. Concrete foundation shall be placed on undisturbed proof rolled soil or on structural fill, approved by the Engineer, placed in 8 inch loose lifts to 95% compaction per ASTM D1557.
- D. Forms and subgrade shall be wetted and all standing water removed prior to placing concrete.
- E. All transporting and handling equipment shall be thoroughly clean.

3.2 FORMWORK

A. Installation

- 1. Set to the shape, line, and grade required and maintained sufficiently rigid to prevent deformation under loading, including placing and compacting concrete.
- 2. Set forms and screeds for floor and decks to provide uniform slopes to drains and positive drainage for exterior slabs and steps.
- 3. Forms shall be tight enough to prevent leakage of mortar. Formwork shall be secured to prevent sagging, yielding, bulging, depressions, waves, or other defects in the finished work.
- 4. Temporary openings shall be provided at the base of column and wall forms for cleaning and inspection. All debris including mud shall be removed before placing concrete.
- 5. Lumber once used shall be cleaned and oiled before reuse.
- 6. Prefabricated panel section systems to be used shall be approved by the Engineer.

B. Earth Surfaces

- 1. Sloped or vertical earth surfaces may be utilized if they are clean cut and stable at time of concrete placement.
- 2. Subgrade surfaces must be free of organics, debris and surface water and must be undisturbed or compacted to 95 % density in accordance with ASTM D1557.

C. Chamfering

- 1. Exposed corners of concrete shall have a 3/4" chamfer.

D. Form Treatment

- 1. Treatment methods are subject to approval by the Engineer as follows;
 - a. Board Forms: Keep wet previous to placing concrete; wet thoroughly just before placing.
 - b. Plywood Forms: For surfaces to be painted use a compatible bond breaker. Clean and coat other surfaces with sufficient stainless form oil for satisfactory removal.
 - c. Metal Forms: Use a release compound.

E. Form Removal

- 1. Side forms of walls and beams may be removed after 1 to 3 days. Load supporting forms and shoring shall not be removed until after a minimum of 7 days and not until two-thirds of designed 28 day compressive strength is obtained.
- 2. All forms shall be completely removed after setting of concrete along with all temporary supports, etc., employed for construction purposes.
- 3. Forms shall be readily removable without hammering or prying against the concrete.

4. Concrete forms shall be left in place or removed and the concrete cured for a minimum of 7 days after concrete placement. Days having temperatures below 40 degrees F are not to be counted as part of the 7 days.

3.3 REINFORCEMENT

A. Splicing

1. Bar splices shall be in accordance with ACI 318 Chapter 12. Any deviation requires approval of the Engineer.
2. Welded splices specified on the drawings or approved by the Engineer at the Contractors request shall conform to AWS D12.1 using a A706 reinforcing steel.

B. Installation

1. Before being placed, reinforcing shall be free from loose flaky rust, oil, grease, mud, or other coating, including ice that would reduce or destroy the bond. Reinforcement shall be accurately placed and properly secured in position by precast concrete squares, metal chairs or spacers. The use of heat to bend or straighten reinforcing is not permitted unless a procedure for heating reinforcement is approved by the Engineer. Tolerances, spacing, splices, and concrete protection shall conform to Chapter 7 and 12 of the ACI 318 Building Code.

C. Ties

1. Reinforcement shall be accurately placed and securely tied at all intersections and splices with 18 gauge black annealed wire. Wire tie ends shall point away from forms.
2. Reinforcement shall be securely held in position during placement of concrete by spacers, chairs, squares, or other approved supports. The number, type, and spacing of supports shall conform to ACI 315 Manual.

D. Stirrups and Ties

1. Stirrups and ties shall be held in place by two spacer bars extending the full length of the member.

E. Mesh

1. Reinforcing mesh shall be located two inches from the surface and spliced with two mesh squares unless indicated otherwise on the drawings.
2. Reinforcing mesh shall be installed by one of the following methods:
 - a. Place concrete to the level where the mesh is to be located. Place the mesh on the struck-off surface and continue pouring to full slab thickness.
 - b. Place mesh on preformed concrete blocks wired to the mesh, pour concrete, and adjust mesh as required.

F. Slabs

1. Re-entrant corners and each face of penetrations shall have one #5 deformed bar extending 36 inches past the face or corner, except for elevated slab and wall penetrations, where the bar shall extend the full short span length.
2. Bars used as dowels in joints shall be 5/8" diameter plain round bars 2' long, capped on one end and spaced 24 inches on center.

G. Synthetic Fiber Secondary Reinforcement

1. When indicated on the drawings, synthetic fiber secondary reinforcement shall be added to the concrete mix to provide concrete crack control.

3.4 EMBEDDED ITEMS

- A. The contractor shall obtain necessary data and information for location and placement of embedded items and items to be placed prior to concrete placement and be responsible for coordination of the trades to place these items.

B. Anchor Rods (Bolts)

1. Embedded anchor rods shall have a nut or head embedded and a nut and washer on the exposed end.
2. Anchor rods shall be set true to the lines and grades shown on the drawings and shall be set plumb and be securely braced to prevent displacement during placing of concrete. Threads shall be protected with an oil or grease coating and encased in burlap or paper. Upon completion of concrete placement, rods shall be rechecked for correct location and elevations.
3. Anchor Tolerances: Anchor rods not conforming to allowable tolerance shall be corrected by the Contractor as directed by the Engineer at no additional cost to the Owner or Engineer. Tolerance limits in setting of anchors and anchor rods shall be as follows:
 - a. Location, sleeved: 3/16 inch (top of anchor and at concrete surface)
 - b. Location, un-sleeved: 1/8 inch (top of anchor and at concrete surface)
 - c. Projection: plus 1/4 inch, minus 0 inch

C. Embedded Metals

1. Installation
 - a. Embedded curb angles, beams, frames, conduits, pipe sleeves and supports, etc. shall be set true to the lines and grades shown on the drawings and secured and braced to prevent shifting during concrete placement.
 - b. Dissimilar metals embedded in direct contact with one another shall have contacting surfaces coated with an Engineer-approved treatment to prevent galvanic coupling.

3.5 CONCRETE MIXING

- A. The mixer and mixing time shall be in accordance with ACI 304. Hot weather concreting shall comply with ACI 305, and cold weather concreting with ACI 306.
- B. No additional water shall be added to batched concrete without the permission of the Engineer.
- C. Concrete shall be mixed only in such quantities as are required for immediate use. The minimum amount of concrete agitation shall be 70 drum revolutions. The maximum allowable time between charging of the material in the mixing drum and final placement for mean ambient temperatures below 90 degrees F shall be 90 minutes, but not more than 300 drum revolutions. Concrete delivered when the mean ambient temperature exceeds 90 degrees F shall be cooled, mixed and delivered in accordance with the requirements of ACI 305. Concrete not placed within time limits or with initial set developed shall not be tempered and shall not be used.

3.6 CONCRETE PLACEMENT

- A. Concrete shall not be placed prior to a recorded pre-placement inspection and/or authorization to proceed by the Engineer or Owner's Representative.

- B. Conveying and placing of concrete shall be in accordance with ACI 304.
- C. Concrete placement shall be properly scheduled to assure surfaces may be finished correctly and the number of construction joints kept to a minimum.
- D. Concrete shall be consolidated by mechanical vibration, except for slabs on grade six inches or less in thickness and for self-consolidating concrete.
- E. Concrete shall be placed in layers not over 24 inches deep. Except for self-consolidating concrete, each layer shall be consolidated by mechanical internal-vibrating equipment supplemented by hand spading, rodding, and tamping to work concrete into corners and narrow places. Duration of vibration shall be limited to the time necessary to produce satisfactory consolidation without segregation.
- F. Vibrators shall be applied vertically and uniformly spaced not farther apart than the visible effectiveness of the machine. A vibrator shall not be inserted into a lower layer that has begun to set or used to transport concrete. The use of form vibration is not permitted.
- G. Free fall of concrete shall not exceed 10 feet for walls 10 inches or less thick or 5 feet for other types of construction.
- H. A tremie or flexible spout may be used to reduce free fall distances. Flexible spouts shall be composed of conical sections with a taper and outlet diameter that retards flow at the outlet.
- I. Chutes, troughs and pipes may be used to aid in placing concrete with restrictions as follows;
 - 1. Concrete ingredients are not allowed to separate.
 - 2. Metal construction or metal-lined equipped with baffle boards or reversed section at the outlet for steep slope concrete placement.
 - 3. May extend inside of forms or through holes left in the forms but ends shall terminate in vertical downspouts.
 - 4. Surfaces are kept clean and free of coatings and hardened concrete.
- J. Concrete shall be deposited, as nearly as possible, in its final position and shall not be laterally transported in the form except in the use of self-consolidating concrete placement. Each pour shall be completed in a continuous operation with no interruptions in excess of forty-five minutes.
- K. The placing sequence shall allow for the effects of settling and shrinkage. Walls 10 feet high and over shall be stopped about 1 foot short of the top and allowed to settle one hour minimum before topping out. Walls and columns bearing superimposed slabs or beams shall be allowed to settle a minimum of two hours before pouring slabs or beams. Laitance shall be removed before placing superimposed structural members.

3.7 JOINTS

- A. Construction, control and expansion joints shall be placed where indicated on the drawings. When joints are not indicated, or the Contractor wants to modify locations, a plan of the proposed locations shall be approved by the Engineer prior to concrete placement.
- B. The surface of construction joints and existing concrete surfaces to come in contact with new concrete shall be roughened to 1/4 inch minimum profile. Laitance, loosened aggregate and damaged concrete near the joint shall be removed. Construction joints shall be in accordance with ACI 318, Chapter 6.4 and subject to approval of the Engineer. A bonding agent shall be placed where indicated on the Drawings.
- C. Waterstop shall be installed in joints where shown on the drawings and form a continuous diaphragm. Waterstop shall be supported to prevent movement and protected from damage during concrete placement.

- D. Begin saw cutting for control joints as soon as concrete sufficiently hardens (normally 4-12 hours) and the cutting does not damage joint edges. There shall be no saw cutting while the concrete temperature is falling. Expansion and control joints shall be filled with sealant and backer rod.
- E. Reinforcing shall be continued across construction joints but not across control joints.
- F. Slabs on grade shall have control joints located along column lines and at intermediate spacing when locations are not indicated on the drawings. The joint spacing shall not be more than 30 times the slab thickness for unreinforced slabs and 45 for reinforced slabs. The "panel" area within joints shall be rectangular with joint spacing in any direction not more than 1.5 times the other. A square slab area around columns shall be placed after adjacent slab placement. The corners of the square shall connect to control joints.

3.8 FINISHING CONCRETE

- A. Form ties shall be broken back 1 inch from the surface of the concrete. Holes remaining shall be filled with a 1 to 2 cement-sand mortar mix.
- B. Voids and honeycombing in formed concrete shall be filled with a 1 to 2 cement-sand mortar mix or repaired as directed by the Engineer. Form ridges and other projections shall be removed immediately after forms are removed. Exposed form concrete shall be rubbed with a carborundum brick and a thin parge coat (1 to 3 cement-sand mix) placed to produce a consistent, even and true finished surface. The parge coat shall extend below grade 6 inches minimum.
- C. Concrete to come in contact with grout shall be roughened to expose aggregate. Loose particles and laitance shall be removed. Anchor rod threads shall be wire brushed and greased after concrete set.

3.9 SLAB SURFACE FINISHING

- A. Exposed concrete surfaces shall be screeded to the elevations shown on the drawings. An evaporation retardant shall be sprayed on screeded surfaces if the air temperature is expected to reach 80 degrees F or above.
- B. Floating shall start as soon as the screeded surface has sufficiently stiffened. Floating shall be performed as necessary to produce a smooth, even, textured finish. Floating shall be performed by hand using magnesium tools. The surface shall be tested with a straight edge after initial floating. Any depressions shall be filled and high areas be cut down and reworked. Straight edge testing and refloating shall continue until there are no deviations more than 1/8 inch within ten feet.
- C. Interior slabs shall be steel troweled unless indicated otherwise. Troweling shall begin after straight edge testing is finished and while the concrete is green, but sufficiently hardened to trowel without causing damage, and produce a smooth finish per ACI Standard 301, Section 11.7.3 "Trowel Finish."
- D. Exterior slabs and other surfaces indicated on the drawings shall be "broomed" after final floating and not troweled to provide a nonskid surface. A soft bristled push broom shall be used in a swirling motion.
- E. Interior smooth non-slip surfaces indicated on the drawings shall have not less than 1/4 pound of abrasive aggregate sprinkled over each square foot of floated concrete. Finishing shall begin immediately with a steel trowel.
- F. Surfaces indicated on the drawings shall have a floor "hardener" material introduced during finishing.
- G. Horizontal surfaces not previously discussed, such as top of walls and pedestals, shall be troweled.

3.10 CURING

- A. Concrete surfaces, except those embedded, shall be cured by one or more methods compatible with the final finish. Curing shall begin as soon as possible and continue a minimum of 7 days after placement in accordance with ACI 301, Chapter 12. The following methods may be used unless a specified curing method is indicated on the drawings:
 - 1. Water curing by ponding or continuous wetting of sand, burlap or equal.
 - 2. Form curing by leaving the forms in place. An alternate curing method shall be used if forms are removed prior to 7 days.
 - 3. Curing compound applied in two applications in directions at 90 degrees to each other.

3.11 COLD WEATHER CONCRETING

- A. Sufficient protection against cold weather damage to concrete shall be made prior and during placement. Cold weather concreting shall be performed in accordance with ACI 306 and this Section.
- B. When the 24 hour temperature falls below 40 degrees F, concrete placement temperature shall be above 50 degrees F and concrete shall be protected from freezing for not less than 7 days.

3.12 HOT WEATHER CONCRETING

- A. Sufficient preparation for protection against hot weather damage to concrete shall be made prior to placement. Hot weather concreting shall be performed in accordance with ACI 305 and this Section when the temperature is above 85 degrees F.
- B. Protection shall be provided so the evaporation rate of the mix water from placed concrete shall not exceed 0.2 pounds of water per square foot per hour.
- C. One or more of the ingredients may be cooled to reduce the temperature of concrete at placement. The replacement of part of the mixing water with an equal weight of crushed ice is recommended for effective cooling per ACI 305, Figure 2.3.6.
- D. In place concrete shall be protected from wind and sun and shall be cured as soon as possible. An evaporation retardant shall be sprayed on exposed surfaces if the air temperature is above 80 degrees F.

3.13 PUMPED CONCRETE

- A. Mix designs for concrete to be pumped shall be submitted to the Engineer.
- B. One reserve pump shall be kept at the site during pumped concrete placement unless the Engineer approves otherwise.

3.14 UNDERGROUND ELECTRICAL CONDUIT CONCRETE

- A. Concrete for underground electrical conduit shall be colored RED and mixed for 10 minutes minimum after color mixture has been added.
- B. Colored concrete shall have a compressive strength of 2,000 psi minimum at 28 days.

3.15 CHANGE ORDER WORK

- A. The Contractor shall be compensated for work directed by the Owner or Engineer that is not included in the scope of the drawings, this Section, or contract documents. The method of compensation is not included in

this Section. There shall be no additional compensation to the Contractor to correct work that was not completed per the drawings, Specifications or as directed by the Engineer or Owner.

3.16 CLEAN UP

- A. Cutting, patching or modifying on any portion of completed work shall not be done unless approved by the Engineer.
- B. Forms, equipment, protective coverings, rubbish and other materials not part of the final work indicated on the drawings or this Section shall be removed from the site after their use is complete.

PART 4 - TESTING AND INSPECTION

4.1 INSPECTION

- A. All forms, reinforcement, embedments, subgrade and anchor rods (bolts) shall be inspected and approved by the Owner's Representative before concrete is placed. If work is found unsatisfactory, as determined by the Engineer, associated work shall not proceed until all defects have been remedied as directed by the Engineer.

4.2 TESTING

- A. Testing and acceptance of tests of concrete shall be done in accordance with ASTM C31, C39, C94, C143, C172, and C173, D75, C136 and C157.
- B. An independent testing laboratory or the concrete supplier engaged by the Contractor and approved by the Owner will be responsible for:
 - 1. Supplying test cylinder molds to the job-site and taking of samples.
 - 2. Testing for air, slump, temperature, compressive strength and aggregate gradation.
 - 3. Preparing test reports.
- C. The Contractor shall supply concrete for all tests.
- D. Concrete shall be sampled, cured, tested and accepted for compressive strength in accordance with ASTM C172, C31, C39 and C94. Compressive test cylinders shall be prepared in sets of four for each test. Samples for each set shall be obtained at the end of the chute or discharge line for pumped concrete and from the same batch of concrete approximately midway through discharge. The minimum amount of sampling shall be as follows:
 - 1. At least one set of cylinders shall be obtained at the beginning of each pour and per 50 cubic yards of concrete unless directed otherwise by the Engineer.
- E. Test cylinder sets shall be dated, numbered consecutively, and identified as to location.
- F. Cylinders shall be immediately stored under wet sand or burlap for about 24 hours after preparation. All vibration or impact shall be avoided during this critical period.
- G. After initial storage, the cylinders (still in their molds) shall be packed in sealed polyethylene bags, wet sand or other resilient material for shipment to the testing laboratory.
- H. Concrete slump tests shall be made in accordance with ASTM C 143 and shall be taken as necessary to assure well-placed concrete.

- I. In-Place Tests: Where questions exist as to the quality of the concrete placed, Engineer may require tests per ASTM C42 or order a load test on structures as outlined in Chapter 20 of ACI 318, Building Code Requirements for Reinforced Concrete.

END OF SECTION 03300

SECTION 05120 - STRUCTURAL AND MISCELLANEOUS STEEL

PART 1 - GENERAL

1.1 SCOPE

- A. This Section covers furnishing all materials, equipment, accessories, tools, services, transportation, labor and supervision required for the detailing, fabrication, delivery, and erection of structural and miscellaneous steel.

1.2 DEFINITIONS

- A. Engineer: Intermountain Consumer Professional Engineers, Inc.
- B. Fabricator: Structural Steel fabricator committed to furnish and deliver steel in accordance with this specification.
- C. Erector: Structural Steel Erector committed to erect steel in accordance with this specification.
- D. "As noted" or "unless noted:" "As indicated" or "unless indicated otherwise " on the drawings or in the Specification.
- E. "For approval" or "to approval:" Approved by the Engineer.

1.3 REFERENCE CODES, SPECIFICATIONS, AND STANDARDS

- A. All work shall be in accordance with this Section of the Specification and the requirements of the latest editions of the following codes, specifications and standards except, as noted.

1. AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

- a. "Steel Construction Manual," Thirteenth Edition
- b. "Code of Standard Practice for Steel Buildings and Bridges," 2000 Edition
- c. "Specification for Structural Steel Buildings," 2005 Edition

2. AMERICAN WELDING SOCIETY (AWS),

- a. D1.1, "Structural Welding Code," 2006 Edition
- b. D2.4, "Standard Symbols for Welding, Brazing, Nondestructive Testing," 1998 Edition
- c. A5.1, "Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding"
- d. A5.17, "Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding"
- e. A5.20, "Specification for Carbon Steel Electrodes for Flux Cored Arc Welding"

3. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- a. A36, "Standard Specification for Structural Steel"
- b. A53, "Standard Specification for Welded and Seamless Steel Pipe"
- c. A307, "Standard Specification for Carbon Steel Externally and internally Threaded Standard Fasteners"
- d. A325, "Standard Specification for High Strength Bolts for Structural Steel Join."
- e. A490, "Standard Specification for Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints"
- f. A563, "Standard Specification for Carbon and Alloy Steel Nuts"

- g. A500, "Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Steel Tubing in Rounds and Shaped"
- h. A501, "Standard Specification for Hot-Formed Welded and Seamless Carbon Structural Tubing"
- i. A992, "Standard Specification for W Shapes"
- j. A786, "Standard Specification for Raised Pattern Floor Plates"
- k. E709, "Standard Guide for Magnetic Particle Examination"
- l. F436, "Standard Specification for Hardened Steel Washers"

1.4 DRAWINGS AND SUBMITTALS

A. Shop and Erection Drawings

1. Information:
 - a. Five sets of Fabricator Drawings shall be submitted to include all shop and erection details including cut, copes, connections, holes, bolts and welds in structural steel. Shop and field welds shall be indicated by standard welding symbols conforming to the American Welding Society. Drawings shall show the size, length and type of each weld per AWS A2.4. Where areas are noted "hold" on a drawing detailing shall not start until the "hold" is removed by the Engineer.
 - b. The drawings shall reference the applicable Project Drawings, have the same orientation as the Project Drawings and include all information required for fabrication and erection.
2. Approval
 - a. Approval by the Engineer of Fabricator Drawings shall not relieve the fabricator of responsibility for accuracy of dimensions or adequacy of design. Only checked drawings will be submitted for approval.
 - b. Material shall not be ordered or fabricated prior to completion of Engineer's review and the indicated revisions have been made to the Fabricator Drawings.
 - c. One copy of each Fabricator Drawing shall be furnished to the Engineer when they are issued to the shop for fabrication.
3. A certificate of conformance to this Section of the Specification shall be furnished to the Engineer with each delivery of fabricated material when requested.
4. A test report for the last completed set of mechanical tests for each size nut shall be furnished to the Engineer in each delivery when requested.
5. Reports of nondestructive testing shall be furnished to the Engineer.
6. Certified mill test reports shall be furnished to the Engineer when requested.

PART 2 - MATERIALS

2.1 STRUCTURAL STEEL

- A. All structural steel materials shall be new and conform to that listed below, unless noted.
 1. Structural steel wide flange and WT shapes shall conform to ASTM A992.
 2. Other structural steel shapes, plates and bars shall conform to ASTM A36.
 3. Steel pipe ($t > 0.625$ ") shall conform to ASTM A53, Grade B.
 4. Hollow structural steel sections shall conform to ASTM A500, Grade B.
 5. High strength bolts shall conform to ASTM A325 or ASTM A490.
 6. Machine bolts or common bolts shall conform to ASTM A307, Grade A.
 7. Anchor rods (bolts) embedded in concrete or masonry shall conform to ASTM F1554, Grade 36, unless noted.

8. All nuts shall conform to A563, Grade A, for A307 or A36 bolts. Nuts for A325 and A490 bolts shall conform to A563, Grade DH, heavy hex or A194, Grade ZH, heavy hex.
9. Washers shall be heavy plate conforming to ASTM F436.
10. Special fasteners, such as self-locking screw threads or self-locking nuts, shall be as specified on the drawings or as approved by the Engineer.
11. Welding electrodes shall be E70XX.
12. Welded steel stud connectors shall be automatic end-weld type conforming to AWS D1.1.
13. Raised pattern floor plates shall conform to ASTM A786 and ASTM A36.

2.2 STRUCTURAL STEEL FABRICATION

A. Assembly

1. Shop fabricated structural steel shall be assembled into units as large as possible consistent with shipping or galvanizing limitations.

B. Fitting

1. Radius for re-entrant flame cuts shall be 3/4" minimum except in members smaller than 8". Shearing, flame cutting, and chipping shall be done carefully and accurately. Sole plates of beams and girders shall have full contact with the flanges. Stiffeners shall be fitted neatly between the flanges or girders and, where tight fits are required to transmit bearing, the ends of stiffeners shall be milled or ground to secure an even bearing against the flange angles. The clearance between the ends of spliced webs shall not exceed 1/4".

C. Draw

1. Allowance shall be made for draw in cross bracing longer than 10'-0".

D. Holes

1. Holes shall be cut, stub-drilled and reamed or punched at right angles to the surface of the metal and shall not be made or enlarged by burning. Holes in base or bearing plates shall be drilled. Holes shall be clean-cut without torn or ragged edges. Outside burrs resulting from drilling or reaming operations shall be removed with a tool making a 1/16" bevel.

E. Erection Clips

1. Fabricator shall furnish and install erection clips for fit-up of field-welded connections.

F. Existing Steel

1. Connections to existing steel shall be field welded unless otherwise indicated.

G. Fabrication Tolerances

1. Fabrication tolerances shall conform to AISC "Code of Standard Practice for Steel Buildings and Bridges."

H. Erection Marks

1. Building Structure Identification

- a. When projects involve more than one building structure, Fabricator shall apply a separate shop order number to each building structure or otherwise suitably identify the steel for each building structure in the project.

2. System of Marking

- a. The system used shall be fabricator's standard practice unless otherwise specified herein.

3. Method of Marking

- a. Shop-painted steel shall be legibly marked with paint of a color different from that used for shop painting. Galvanized steel shall be marked with metal tags wired to each member or with 1" high metal die-stamped letters legibly imprinted prior to galvanizing.

I. Specific Details

- 1. Gusset and stiffener plates shall be a minimum of 3/8" thick.
- 2. Columns shall have full bearing at splices and at base plates.
- 3. Axially loaded members shall meet at a point so as to preclude induced bending moments into the members. If this is not practicable, provisions shall be made for induced bending stresses.

J. Materials Preparation

- 1. Material shall have clean surfaces before fabricating. Joint surfaces, including those adjacent to washers, shall be free of dirt, loose scale, burrs or other defects that would prevent solid seating of all parts.
- 2. Members shall be free of twists, bends, or loose joints.
- 3. Bolt holes shall be drilled or punched 1/16" larger than the nominal diameter of as noted.
- 4. Column base plates exceeding 15/16" in thickness shall be thermal cut by machine to the size specified.
- 5. Beams shall be fabricated with natural camber up.
- 6. Welding shall be in accordance with AWS D1.1;
 - a. Welders and welding operators shall hold current certification in accordance with AWS D1.1 to perform the type of welding required.
 - b. The technique of welding employed, the appearance, quality of welds made and methods used in correcting defective work shall conform to AWS D1.1.
 - c. Except for stud connectors, welds shall be either by manual shielded metal-arc welding, submerged arc welding or flux cored arc welding processes. Electrodes shall conform to AWS A5.1, E70 Series, for manual shielded metal-arc welding. For submerged arc welding, electrodes and granular flux shall conform to AWS 5.17, F7X-EXXX Classification. For flux cored arc welding, electrodes and flux shall conform to AWS A5.20, E70 T-X series.
 - d. Tack welds which are not incorporated into the final weld and inadvertent arc strikes shall be removed and ground smooth.
 - e. Welding run-off tabs shall be cut off and ground smooth at the edge of the finished member.
 - f. Stud connectors shall be installed conforming to AWS D.1.1.
 - g. In addition to 100% visual inspection, the Fabricator shall, at no charge to the Owner, inspect 10% of all shop welded connections using either dye penetrant inspection conforming to ASTM E709. Additional testing noted on the drawings or herein shall be provided by the Fabricator at no additional cost to the Owner.
 - h. When field welding is specified on the drawings, the Fabricator shall furnish and install suitable erection supports.

K. Connections

1. The design of AISC standard connections not specifically detailed on the drawings shall be the responsibility of the Fabricator and subject to approval.
2. Connections for main members, including all bracing, shall employ high strength bolts or welds. Bearing type bolt connections with two bolts minimum shall be used except as noted. Machine or common bolts may be used for purlin, girt and other auxiliary member connections. Butt welds shall be full penetration and abutting joint surfaces shall be sealed with a 1/8" weld. The minimum diameter of bolts shall be 3/4," except when a member size does not permit, in which case the largest bolt diameter permissible shall be used
3. Beam connections shall be designed for the loads indicated on the drawings. If no loads are indicated, connection configurations shall be as outlined in Parts 9 thru 13 of the AISC Manual of Steel Construction. Single plate tab connections shall be used where possible.
4. Shop connections shall be welded when possible. High strength bolts may be used where welding is uneconomical or impractical, subject to approval.
5. Field connections shall be bolted unless noted.
6. ASTM A325 high strength bolts shall be installed snug fit conforming to "Specification for Structural Joints Using ASTM A325 or A490 Bolts," unless noted otherwise and for the lateral bracing system connections noted, which shall be slip critical, Class A.
7. Fabricator shall furnish two percent (2%) additional bolts, nuts, washers, load indicators and grating saddle clips to allow for loss during erection.

L. Bracing

1. Vertical Bracing
 - a. Minimum connections for axially loaded bracing members shall be designed for the loads shown on the drawings or the allowable tensile capacity of the member where the loads are not shown.
2. Horizontal Bracing
 - a. Connections for horizontal bracing shall be the greater of one-half the allowable tensile capacity of the brace or the forces shown on the drawings.
3. All axially stressed members shall have their gravity axis meet at a common point, if practicable. Otherwise, the member and connection shall be designed to withstand moments caused by the eccentricities.

2.3 MISCELLANEOUS STEEL

- A. Miscellaneous steel shall include the following items. The following list of items is not intended to be all-inclusive but to illustrate major categories.
 1. Fabricated steel frames for openings and miscellaneous fabricated steel access doors
 2. Handrailing, kick plates, grating, floor plate, treads, nosing, ladders and cages etc.
 3. Ceiling framing smaller than 3" together with hangers and fastenings as noted
 4. Guards, steel thresholds, etc.
 5. Embedded items

2.4 MISCELLANEOUS STEEL FABRICATION

A. Metal Grating and Treads

1. Grating shall be standard removable welded grating 1-1/4" by 3/16" bearing bars at 1-3/16" centers and cross bars at 4" centers unless noted.
2. Stair treads shall be standard grating with 12 gauge checker plate nosing. The treads shall be fabricated from serrated, welded grating having 1-1/4" by 3/16" bearing bars at 1-3/16" centers and cross bars at 4" centers unless noted. A non-slip nosing shall be provided on platforms at the head of stairs.
3. Grating shall be banded at the perimeter of grating floor areas, but not at ends of individual sections of continuous grating within a floor area. Banding bars shall be of the same thickness as the bearing bars and be welded to the grating.
4. Penetrations smaller than 4 inches shall not have banding. Penetrations 4 to 10 inches shall be banded per Paragraph 2.4A.3. Penetrations larger than 10 inches shall have a 1/4 inch thick kick plate projecting 4 inches above the grating surface. Penetrations larger than 24 inches shall be reviewed by the Engineer to determine if additional grating support is necessary.
5. Dimensions of penetrations on the drawings shall be included in fabrication. Penetrations not dimensioned shall be field cut as required.
6. Grating fasteners for painted steel shall be saddle clip anchors secured to the supports with power tool fastened studs or self-drilling and tapping studs
7. Grating and treads to be galvanized shall have all components galvanized, unless noted.

B. Floor Plate

1. Floor plate shall have an embossed diamond surface and be 1/4" thick, unless noted, and connected to supporting grating with 3/16 inch x 1 inch fillet welds at 24 inches in each direction.
2. Removable plate shall be attached to supports with 1/2" diameter, countersunk flathead, machine bolts spaced at 2'-0. Fixed plate shall be welded to supports with 1/2" diameter plug welds spaced at 2'-0. The minimum number of connections per panel is four.
3. Removable plate section locations shall be indicated on the drawings. Plate shall be fabricated with two 1" diameter holes for lifting. Total weight of removable floor plate sections shall not exceed 150 pounds.
4. Penetrations through plate greater than 4" in diameter shall have 1/4" kick plates projecting 4" above the surface. Removable floor plate shall be split around penetrations.
5. Floor plate and kick plates shall be flat without bends, dents, burrs, or sharp edges.

C. Handrail

1. Handrail shall conform to applicable codes and free of burrs and sharp edges.

D. Embeds

1. Embeds shall be straight and free of dents, burrs and sharp edges.
2. Anchorage shall be 1/2" diameter rods with a bolt or bent end spaced at 2'-0, unless noted.

2.5 COATINGS

A. Galvanized

1. Grating, treads and embedded items shall be galvanized unless noted. Other surfaces to be galvanized shall be indicated on the drawings. Galvanizing of steel shall conform to ASTM standard specifications for hot-dip zinc coating designation A123, A143, A153, A384, A385 and A386, latest revision.
2. The maximum damaged areas that may be repaired without re-galvanizing shall conform to ASTM

A123. Repairs shall conform to ASTM A780.

B. Painted

1. Steel surfaces shall be painted unless designated otherwise or furnished coated. Surfaces to be painted shall be cleaned by commercial blast per the Structural Steel Painting Council (SSPC) SP-6 and receive one 3 mil dry film thick shop coat of Pro-Cryl Universal Primer by Sherwin Williams or an approved equal. Handrail and bollards shall be painted with a safety yellow finish coat, unless noted.

2.6 INSPECTION AND TESTING

- A. The Fabricator shall include a Quality Control Program with sufficient inspections and tests to assure conformance to contract requirements. A description of this program shall be submitted to the Engineer when requested. The Fabricator shall allow the Engineer or his Representative to inspect fabrication methods or materials at any time.
- B. Engineer may perform non-destructive (visual and dye-penetrant, magnetic particle, ultrasonic or radiographic) testing to ensure quality of welds. Should testing or inspection reveal that welds of any welder contain defects which may affect the strength or durability of the structure, such welder may be permanently removed from the work and any such welds shall be repaired and tested as directed by the Engineer at no additional cost to the Owner.
- C. Where specified on the drawings, non-destructive testing shall be performed and documented in the shop by the Fabricator. Results of testing shall be submitted to the Engineer for approval.

2.7 SHIPPING AND DELIVERY

- A. The Fabricator shall deliver the materials to the project site in accordance with the detailing and fabrication/delivery schedule.
- B. Materials shall be loaded and braced on the transport vehicle to prevent damage during shipment.
- C. The Erector shall visually inspect deliveries for damage prior to unloading. All damaged material shall be acknowledged by the Fabricator's delivery agent and repaired or replaced by the Fabricator and/or Erector at no additional cost to the Owner.
- D. Shipping lists shall accompany each shipment of steel.
- E. Small pieces shall be bundled with steel bands or crated to prevent damage during shipment.

PART 3 - ERECTION

- 3.1 Splices and field connections shall be made with high strength bolts unless machine bolts are specifically indicated.
- 3.2 Bases and bearing plates may be attached or loose. Base plates and bearing plates shall generally be supported and aligned on steel wedges or shims. After the supported members have been plumbed and properly positioned and the anchor nuts tightened, the entire bearing area under the plate shall be filled with a non-shrink grout conforming to Section 03300.
- 3.3 After assembly, the various members forming parts of a completed frame or structure shall be aligned and adjusted accurately before being permanently fastened. Tolerances shall conform to the AISC "Code of Standard Practice for Steel Buildings and Bridges." Fastening of splices of compression members shall be done after the abutting surfaces have been brought completely into contact. Bearing surfaces and surfaces

that will be in permanent contact shall be cleaned before the members are assembled. As erection progresses, the work shall be securely fastened or braced to resist all dead load, wind and erection stresses. Unless removal is required, all erection bolts used in welded construction may be tightened securely and left in place. If erection bolts are removed, the holes shall be filled with plug welds. Holes shall not be enlarged more than 1/16" greater than the specified size without approval of the Engineer.

- 3.4 Drift pins may be used only to bring together the parts and shall not be used in such a manner as to distort or damage the metal.
- 3.5 Structural material, either plain or fabricated, shall be stored above the ground upon platforms, skids, or other supports. Material shall be kept free from dirt, grease and other foreign matter and shall be protected from corrosion.
- 3.6 All damage to steel and coatings shall be repaired or replaced as directed by the Owner. Fabricator shall be responsible for damage until material delivery. The Erector is responsible when he begins handling the material.

PART 4 - INSPECTION AND TESTING

- 4.1 The Fabricator shall establish and perform a shop inspection system for sufficient inspections and tests to assure conformance to contract requirements. This Quality Control Program shall be submitted to the Engineer prior to fabrication when requested. The Engineer reserves the right of inspection for its representative and for its client during fabrication
- 4.2 Engineer may perform non-destructive (visual and dye-penetrant, magnetic particle, ultrasonic or radiographic) testing to ensure quality of welds. Should inspection reveal that the welds of any welder contain defects which may affect the strength or durability of the structure, such welder may be permanently removed from the work and any such welds shall be repaired and tested as directed by the Engineer at no additional cost to the Owner.
- 4.3 Where specified, and to the extent shown on the Drawings, non-destructive testing shall be performed and documented in the shop by the Fabricator. All results of such testing shall be submitted to the Engineer for review.

END OF SECTION 05120

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Grout.
 - 6. Mechanical demolition.
 - 7. Equipment installation requirements common to equipment sections.
 - 8. Concrete bases.
 - 9. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl-spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, cir-

circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- E. Welding Filler Metals: Comply with AWS D10.12.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and non-corrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure of 225 deg F.

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Carbon steel. Include two for each sealing element.

- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

- A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- B. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

2.6 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume adjusting, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

- A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated for removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- M. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- N. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.9 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 15050

SECTION 15055 - MOTORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes basic requirements for factory- and field-installed motors.
- B. See Division 15 Section "Mechanical Vibration and Seismic Controls" for mounting motors and vibration isolation and seismic-control devices.
- C. See individual Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

1.2 SUBMITTALS

- A. Product Data for Field-Installed Motors: For each type and size of motor, provide nameplate data and ratings; shipping, installed, and operating weights; enclosure type and mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.
- B. Shop Drawings for Field-Installed Motors: Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
 - 1. Each installed unit's type and details.
 - 2. Nameplate legends.
 - 3. Diagrams of power, signal, and control wiring. Provide schematic wiring diagram for each type of motor and for each control scheme.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.4 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:
 - 1. Compatible with the following:
 - a. Magnetic controllers.
 - b. Multi-speed controllers.
 - c. Reduced-voltage controllers.

2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
 3. Matched to torque and horsepower requirements of the load.
 4. Matched to ratings and characteristics of supply circuit and required control sequence.
- B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.
- C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

- A. Motor requirements apply to factory- and field-installed motors except as follows:
1. Different ratings, performance, or characteristics for motor are specified in another Section.
 2. Motorized-equipment manufacturer requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.2 MOTOR CHARACTERISTICS

- A. Motors 1/2 HP and Larger: Three-phase.
- B. Motors Smaller Than 1/2 HP: Single-phase.
- C. Frequency Rating: 60 Hz.
- D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
- E. Service Factor: 1.15 for open drip-proof motors; 1.0 for totally enclosed motors.
- F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
- G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- H. Enclosure: Open drip-proof.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Standard, as defined in NEMA MG 1.
- C. Stator: Copper windings, unless otherwise indicated.
1. Multi-speed motors shall have separate winding for each speed.
- D. Rotor: Squirrel cage, unless otherwise indicated.
- E. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading.

- F. Temperature Rise: Match insulation rating, unless otherwise indicated.
- G. Insulation: Class F, unless otherwise indicated.
- H. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- I. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.
 - 1. Finish: Gray enamel.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:
 - 1. Measure winding resistance.
 - 2. Read no-load current and speed at rated voltage and frequency.
 - 3. Measure locked rotor current at rated frequency.
 - 4. Perform high-potential test.

2.5 SINGLE-PHASE MOTORS

- A. Type: One of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split-phase start, capacitor run.
 - 3. Capacitor start, capacitor run.
- B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
- C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, pre-lubricated-sleeve type for other single-phase motors.
- E. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:
 - 1. Measure winding resistance.
 - 2. Read no-load current and speed at rated voltage and frequency.
 - 3. Measure locked rotor current at rated frequency.
 - 4. Perform high-potential test.

PART 3 - EXECUTION

3.1 FIELD-INSTALLED MOTOR INSTALLATION

- A. Anchor each motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and align with load transfer link.
- B. Install motors on concrete bases complying with Division 3.
- C. Comply with mounting and anchoring requirements specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

3.2 FIELD QUALITY CONTROL FOR FIELD-INSTALLED MOTORS

- A. Prepare for acceptance tests.
 - 1. Align motors, bases, shafts, pulleys, and belts. Tension belts according to manufacturer's written instructions.
 - 2. Verify bearing lubrication.
 - 3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
 - 4. Test interlocks and control and safety features for proper operation.
 - 5. Verify that current and voltage for each phase comply with nameplate rating and NEMA MG 1 tolerances.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform electrical tests and visual and mechanical inspections including optional tests and inspections stated in NETA ATS on factory- and field-installed motors. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION 15055

SECTION 15060 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.
- B. See Division 5 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
- C. See Division 15 Section "Mechanical Vibration and Seismic Controls" for vibration isolation devices.

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Available Manufacturers:
 - 1. AAA Technology & Specialties Co., Inc.
 - 2. Bergen-Power Pipe Supports.
 - 3. B-Line Systems, Inc.; a division of Cooper Industries.
 - 4. Carpenter & Paterson, Inc.
 - 5. Empire Industries, Inc.
 - 6. ERICO/Michigan Hanger Co.
 - 7. Globe Pipe Hanger Products, Inc.
 - 8. Grinnell Corp.
 - 9. GS Metals Corp.
 - 10. National Pipe Hanger Corporation.
 - 11. PHD Manufacturing, Inc.
 - 12. PHS Industries, Inc.
 - 13. Piping Technology & Products, Inc.
 - 14. Tolco Inc.
- C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. GS Metals Corp.
 - 4. Power-Strut Div.; Tyco International, Ltd.
 - 5. Thomas & Betts Corporation.
 - 6. Tolco Inc.
 - 7. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimums, compressive-strength insulation insert encased in sheet metal shield.

B. Available Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

- a. Hilti, Inc.
- b. ITW Ramset/Red Head.
- c. Masterset Fastening Systems, Inc.
- d. MKT Fastening, LLC.
- e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

- a. B-Line Systems, Inc.; a division of Cooper Industries.
- b. Empire Industries, Inc.
- c. Hilti, Inc.
- d. ITW Ramset/Red Head.
- e. MKT Fastening, LLC.
- f. Powers Fasteners.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, non-corrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 - 5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 - 7. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 - 8. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - 6. C-Clamps (MSS Type 23): For structural shapes.
 - 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 - 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 - 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 - 3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- M. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 15060

SECTION 15073 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restraining braces and cables.

1.2 PERFORMANCE REQUIREMENTS

- A. Per locally accepted codes.

1.3 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - 1. Amber/Booth Company, Inc.
 - 2. California Dynamics Corporation.
 - 3. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 4. Hilti, Inc.
 - 5. Kinetics Noise Control.
 - 6. Loos & Co.; Cableware Division.
 - 7. Mason Industries.
 - 8. TOLCO Incorporated; a brand of NIBCO INC.
 - 9. Unistrut; Tyco International, Ltd.
- C. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

- E. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- F. Hanger Rod Stiffener: [Steel tube or steel slotted-support-system sleeve with internally bolted connections] [Reinforcing steel angle clamped] to hanger rod.
- G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolt and studs.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inches.
 - 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

G. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross-seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 15 Section "Domestic Water Piping" for piping flexible connections.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 15073

SECTION 15075 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment markers.
3. Equipment signs.
4. Pipe markers.
5. Valve tags.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:
 - a. Manufacturer, product name, model number, and serial number.
 - b. Capacity, operating and power characteristics, and essential data.
 - c. Labels of tested compliances.
2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
6. Maintain consistency in type of marker used throughout the project.

- B. Pre-tensioned Pipe Markers: Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- C. Shaped Pipe Markers: Preformed semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.
- D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
 - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.
 - 1. Material: 0.032-inch- thick brass or aluminum.
 - 2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.
 - 3. Maintain consistency in the type of marker used throughout the project.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
 - 1. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
 - 2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
 - 1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 - 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Meters, gages, thermometers, and similar units.

- c. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
 - d. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 - e. Tanks and pressure vessels.
 - f. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
- C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
 - 1. Identify mechanical equipment with equipment markers in the following color codes:
 - a. Yellow: For heating equipment and components.
 - 2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 - 4. Include signs for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
 - c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 - d. Tanks and pressure vessels.
 - e. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
 - 1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pre-tensioned pipe markers. Use size to ensure a tight fit.
 - 2. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 - 3. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
 - 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and non-accessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 - b. Gas: 1-1/2 inches, round.
 - c. Steam: 1-1/2 inches, round.
 - 2. Valve-Tag Color:
 - a. Match existing.
 - 3. Letter Color:
 - a. Match existing.

3.5 ADJUSTING AND CLEANING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.
- B. Clean faces of mechanical identification devices.

END OF SECTION 15075

SECTION 15080 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes mechanical insulation for boiler breeching, duct, equipment, and pipe, including the following:
 - 1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - d. Polyolefin.
 - e. Polystyrene.
 - 2. Fire-rated insulation systems.
 - 3. Insulating cements.
 - 4. Adhesives.
 - 5. Mastics.
 - 6. Sealants.
 - 7. Factory-applied jackets.
 - 8. Field-applied fabric-reinforcing mesh.
 - 9. Field-applied jackets.
 - 10. Tapes.
 - 11. Securements.
 - 12. Corner angles.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control inspection reports.

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSULATION MATERIALS

- A. Refer to Part 3 schedule articles for requirements about where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50-ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 1. Products:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; All-Service Duct Wrap.
- G. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
 1. Products:
 - a. Johns Manville; HTB 23 Spin-Glas.
 - b. Owens Corning; High Temperature Flexible Batt Insulations.
- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 1. Products:
 - a. CertainTeed Corp.; Commercial Board.
 - b. Fibrex Insulations Inc.; FBX.
 - c. Johns Manville; 800 Series Spin-Glas.
 - d. Knauf Insulation; Insulation Board.
 - e. Manson Insulation Inc.; AK Board.
 - f. Owens Corning; Fiberglas 700 Series.
- I. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.

1. Products:

- a. Fibrex Insulations Inc.; FBX.
- b. Johns Manville; 1000 Series Spin-Glas.
- c. Owens Corning; High Temperature Industrial Board Insulations.
- d. Rock Wool Manufacturing Company; Delta Board.
- e. Roxul Inc.; Roxul RW.
- f. Thermafiber; Thermafiber Industrial Felt.

J. Mineral-Fiber, Preformed Pipe Insulation:

1. Products:

- a. Fibrex Insulations Inc.; Coreplus 1200.
- b. Johns Manville; Micro-Lok.
- c. Knauf Insulation; 1000 Pipe Insulation.
- d. Manson Insulation Inc.; Alley-K.
- e. Owens Corning; Fiberglas Pipe Insulation.

- 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
- 3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

K. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

1. Products:

- a. Knauf Insulation; Permawick Pipe Insulation.
- b. Owens Corning; VaporWick Pipe Insulation.

L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ or FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:

- a. CertainTeed Corp.; CrimpWrap.
- b. Johns Manville; MicroFlex.
- c. Knauf Insulation; Pipe and Tank Insulation.
- d. Manson Insulation Inc.; AK Flex.
- e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.3 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products:

- a. Insulco, Division of MFS, Inc.; SmoothKote.
- b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
- c. Rock Wool Manufacturing Company; Delta One Shot.

2.4 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products:

- a. Childers Products, Division of ITW; CP-82.
- b. Foster Products Corporation, H. B. Fuller Company; 85-20.
- c. ITW TACC, Division of Illinois Tool Works; S-90/80.
- d. Marathon Industries, Inc.; 225.
- e. Mon-Eco Industries, Inc.; 22-25.

- C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Available Products:

- a. Childers Products, Division of ITW; CP-82.
- b. Foster Products Corporation, H. B. Fuller Company; 85-20.
- c. ITW TACC, Division of Illinois Tool Works; S-90/80.
- d. Marathon Industries, Inc.; 225.
- e. Mon-Eco Industries, Inc.; 22-25.

- D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Available Products:

- a. Dow Chemical Company (The); 739, Dow Silicone.
- b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
- c. P.I.C. Plastics, Inc.; Welding Adhesive.
- d. Red Devil, Inc.; Celulon Ultra Clear.
- e. Speedline Corporation; Speedline Vinyl Adhesive.

2.5 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates: Comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products:

- a. Childers Products, Division of ITW; CP-35.
- b. Foster Products Corporation, H. B. Fuller Company; 30-90.
- c. ITW TACC, Division of Illinois Tool Works; CB-50.
- d. Marathon Industries, Inc.; 590.
- e. Mon-Eco Industries, Inc.; 55-40.

- f. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
- 1. Products:
 - a. Childers Products, Division of ITW; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
 - d. Marathon Industries, Inc.; 550.
 - e. Mon-Eco Industries, Inc.; 55-50.
 - f. Vimasco Corporation; WC-1/WC-5.
 - 2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 200 deg F.
 - 4. Solids Content: 63 percent by volume and 73 percent by weight.
 - 5. Color: White.

2.6 SEALANTS

A. Joint Sealants:

- 1. Materials shall be compatible with insulation materials, jackets, and substrates.
- 2. Permanently flexible, elastomeric sealant.
- 3. Service Temperature Range: Minus 100 to plus 300 deg F.
- 4. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

- 1. Products:
 - a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F.
- 5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

- 1. Products:
 - a. Childers Products, Division of ITW; CP-76.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F.

5. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - a. Products:
 - (1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 8. Vinyl Jacket: UL-rated white vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Products:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White.
 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

D. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

1. Products:

a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.

E. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.9 TAPES

A. ASJ Tape: White vapor-retardant tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retardant tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches.
2. Film Thickness: 4 mils.
3. Adhesive Thickness: 1.5 mils.
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch in width.

E. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches.
2. Film Thickness: 6 mils.

3. Adhesive Thickness: 1.5 mils.
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch in width.

2.10 SECUREMENTS

- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.
- B. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Base plate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 1. Base plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 2. Spindle: Copper- or zinc-coated, low carbon steel or Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 3. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- C. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Base plate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 1. Base plate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 2. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 3. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- D. Self-Sticking-Base Insulation Hangers: Base plate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 1. Base plate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 2. Spindle: Copper- or zinc-coated, low carbon steel or Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 3. Adhesive-backed base with a peel-off protective cover.
- E. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel or aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- F. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- G. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- H. Wire: 0.062-inch soft-annealed, stainless steel.

2.11 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 COMMON INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation with tightly butted joints free of voids and gaps. Vapor barriers shall be continuous. Before installing jacket material, install vapor-barrier system.
- C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- H. Keep insulation materials dry during application and finishing.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. Hangers and Anchors: Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thickness.
- M. Install insulation with factory-applied jackets as follows:
 1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- Q. For above ambient services, do not install insulation to the following:
 1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Fire stopping and fire-resistive joint sealers are specified in Division 7 Section "Through-Penetration Firestop Systems."
- F. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Pipe: Install insulation continuously through floor penetrations.
 3. Seal penetrations through fire-rated assemblies according to Division 7 Section "Through-Penetration Firestop Systems."

3.4 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 3. Protect exposed corners with secured corner angles.
 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not over compress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 5. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.
 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end.

Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch pre-stressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, hand holes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, hand holes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply vapor-barrier mastic to open ends, joints, seams, breaks, and punctures in insulation. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

B. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.040 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 PIPE INSULATION INSTALLATION

- A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Secure single-layer insulation with bands at 12-inch intervals and tighten bands without deforming insulation materials.
- C. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with bands at 12-inch intervals.
- D. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- E. Cover segmented insulated surfaces with a layer of insulating cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
- F. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
- G. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

H. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed insulation to pipe with wire or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
5. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

I. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of same insulation material and thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
5. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

J. Insulation Installation on Pipe Fittings and Elbows:

1. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
2. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

K. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
5. Install insulation to flanges as specified for flange insulation application.

- L. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- M. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
 - 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical centerline of valve body.
 - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where PVDC jackets are indicated, install as follows:
 - 1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
 - 2. Wrap factory-presize jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presize jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
 - 3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
 - 4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhe-

sive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.

5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.7 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Remove defective Work.

C. Install new insulation and jackets to replace insulation and jackets removed for inspection. Repeat inspection procedures after new materials are installed.

3.8 BOILER BREECHING INSULATION SCHEDULE

- A. Exposed, Breeching and Connector Insulation: High-temperature mineral-fiber blanket or board, 3 inches thick and 3-lb/cu. ft. nominal density.
- B. Concealed, Breeching and Connector Insulation: High-temperature mineral-fiber blanket or board, 3 inches thick and 3-lb/cu. ft. nominal density.

3.9 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Heating-Hot-Water Pump Insulation: Mineral-fiber board, 2 inches thick.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Fire-suppression piping.
 2. Drainage piping located in crawl spaces.
 3. Below-grade piping.
 4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 OUTDOOR PIPING INSULATION SCHEDULE

- A. Loose-fill insulation, for belowground piping, is specified in Division 2 piping distribution Sections.
- B. Domestic Water Piping: Insulation shall be the following:
 - 1. Mineral-fiber pipe insulation, Type I, 2 inches thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
 - 1. None.
 - 2. PVC, 30 mils thick.
- D. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
 - 1. None.
 - 2. Painted aluminum, smooth with 1-1/4-inch- deep corrugations, 0.040 inch thick.
- E. Piping, Concealed:
 - 1. None.
 - 2. PVC, 30 mils thick.
- F. Piping, Exposed:
 - 1. All piping in boiler room that is exposed is to have painted aluminum jacket to match existing, with corrugations, 0.010 inch thick.

END OF SECTION 15080

SECTION 15110 – VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following general-duty valves:
 - 1. Copper-alloy ball valves.
 - 2. Ferrous-alloy butterfly valves.
 - 3. Bronze check valves.
 - 4. Gray-iron swing check valves.
 - 5. Spring-loaded, lift-disc check valves.
 - 6. Bronze gate valves.
 - 7. Cast-iron gate valves.
 - 8. Bronze globe valves.
 - 9. Cast-iron globe valves.
- B. See Division 2 piping Sections for general-duty and specialty valves for site construction piping.
- C. See Division 15 Section "HVAC Instrumentation and Controls" for control valves and actuators.
- D. See Division 15 piping Sections for specialty valves applicable to those Sections only.

1.2 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; furnished specialties; and accessories.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.9 for building services piping valves.
 - 1. Exceptions: Domestic hot- and cold-water piping valves unless referenced.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: NPS 2 and Smaller: Threaded ends, unless otherwise indicated.
- C. Ferrous Valves NPS 2-1/2 and Larger: Flanged ends, unless otherwise indicated.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
 - 1. Hand wheel: For valves other than quarter-turn types.
 - 2. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
- G. Extended Valve Stems: On insulated valves.
- H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- I. Valve Bypass and Drain Connections: MSS SP-45.

2.3 COPPER-ALLOY BALL VALVES

- A. Manufacturers:
 - 1. One-Piece, Copper-Alloy Ball Valves:
 - a. American Valve, Inc.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. DynaQuip Controls.
 - f. Grinnell Corporation.
 - g. Jamesbury, Inc.
 - h. Kitz Corporation of America.
 - i. Legend Valve & Fitting, Inc.
 - j. NIBCO INC.
 - k. Watts Industries, Inc.; Water Products Div.
 - 2. Two-Piece, Copper-Alloy Ball Valves:
 - a. Conbraco Industries, Inc.; Apollo Div.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. DynaQuip Controls.
 - f. Flow-Tek, Inc.
 - g. Grinnell Corporation.
 - h. Hammond Valve.
 - i. Honeywell Braukmann.
 - j. Jamesbury, Inc.
 - k. Jomar International, LTD.

- l. Kitz Corporation of America.
 - m. Legend Valve & Fitting, Inc.
 - n. Milwaukee Valve Company.
 - o. Nexus Valve Specialties.
 - p. NIBCO INC.
 - q. R & M Energy Systems (Borger, TX).
 - r. Red-White Valve Corp.
 - s. Richards Industries; Marwin Ball Valves.
 - t. Watts Industries, Inc.; Water Products Div.
3. Three-Piece, Copper-Alloy Ball Valves:
- a. Conbraco Industries, Inc.; Apollo Div.
 - b. DynaQuip Controls.
 - c. Grinnell Corporation.
 - d. Hammond Valve.
 - e. Jamesbury, Inc.
 - f. Kitz Corporation of America.
 - g. NIBCO INC.
 - h. PBM, Inc.
 - i. Red-White Valve Corp.
 - j. Worcester Controls.
4. Safety-Exhaust, Copper-Alloy Ball Valves:
- a. Conbraco Industries, Inc.; Apollo Div.
 - b. DynaQuip Controls.
 - c. Grinnell Corporation.
 - d. Hammond Valve.
 - e. Jamesbury, Inc.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
- B. Copper-Alloy Ball Valves, General: MSS SP-110.
- C. One-Piece, Copper-Alloy Ball Valves: Brass or bronze body with chrome-plated bronze ball, PTFE or TFE seats, and 400-psig minimum CWP rating.
- D. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
- E. Three-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
- F. Safety-Exhaust, Copper-Alloy Ball Valves: Two-piece bronze body with exhaust vent opening, chrome-plated ball with vent, blowout-proof stem, locking handle, and working pressure rating of 400-psig CWP.
- 2.4 FERROUS-ALLOY BUTTERFLY VALVES
- A. Manufacturers:
- 1. Flangeless, Ferrous-Alloy Butterfly Valves:
 - a. American Valve, Inc.
 - b. Bray International, Inc.
 - c. Cooper Cameron Corp.; Cooper Cameron Valves Div.

- d. Crane Co.; Crane Valve Group; Center Line.
 - e. Crane Co.; Crane Valve Group; Stockham Div.
 - f. Dover Corp.; Dover Resources Company; Norriseal Div.
 - g. General Signal; DeZurik Unit.
 - h. Grinnell Corporation.
 - i. Hammond Valve.
 - j. Kitz Corporation of America.
 - k. Legend Valve & Fitting, Inc.
 - l. Metraflex Co.
 - m. Milwaukee Valve Company.
 - n. Mueller Steam Specialty.
 - o. NIBCO INC.
 - p. Process Development & Control.
 - q. Red-White Valve Corp.
 - r. Techno Corp.
 - s. Tyco International, Ltd.; Tyco Valves & Controls.
 - t. Watts Industries, Inc.; Water Products Div.
2. Single-Flange, Ferrous-Alloy Butterfly Valves:
- a. American Valve, Inc.
 - b. Bray International, Inc.
 - c. Cooper Cameron Corp.; Cooper Cameron Valves Div.
 - d. Crane Co.; Crane Valve Group; Center Line.
 - e. Crane Co.; Crane Valve Group; Jenkins Valves.
 - f. Crane Co.; Crane Valve Group; Stockham Div.
 - g. Dover Corp.; Dover Resources Company; Norriseal Div.
 - h. General Signal; DeZurik Unit.
 - i. Grinnell Corporation.
 - j. Hammond Valve.
 - k. Kitz Corporation of America.
 - l. Legend Valve & Fitting, Inc.
 - m. Metraflex Co.
 - n. Milwaukee Valve Company.
 - o. Mueller Steam Specialty.
 - p. NIBCO INC.
 - q. Process Development & Control.
 - r. Red-White Valve Corp.
 - s. Techno Corp.
 - t. Tyco International, Ltd.; Tyco Valves & Controls.
 - u. Watts Industries, Inc.; Water Products Div.
- B. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, for tight shutoff, with disc and lining suitable for potable water, unless otherwise indicated.
- C. Flangeless, 150-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer type with one-piece stem.
- D. Single-Flange, 150-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer-lug type with one-piece stem.
- 2.5 BRONZE CHECK VALVES
- A. Manufacturers:
- 1. Type 1, Bronze, Horizontal Lift Check Valves with Metal Disc:

- a. Cincinnati Valve Co.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Red-White Valve Corp.
 - e. Walworth Co.
2. Type 1, Bronze, Vertical Lift Check Valves with Metal Disc:
- a. Cincinnati Valve Co.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Red-White Valve Corp.
3. Type 3, Bronze, Swing Check Valves with Metal Disc:
- a. American Valve, Inc.
 - b. Cincinnati Valve Co.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Crane Co.; Crane Valve Group; Jenkins Valves.
 - e. Crane Co.; Crane Valve Group; Stockham Div.
 - f. Grinnell Corporation.
 - g. Hammond Valve.
 - h. Kitz Corporation of America.
 - i. Legend Valve & Fitting, Inc.
 - j. Milwaukee Valve Company.
 - k. NIBCO INC.
 - l. Powell, Wm. Co.
 - m. Red-White Valve Corp.
 - n. Walworth Co.
 - o. Watts Industries, Inc.; Water Products Div.
- B. Bronze Check Valves, General: MSS SP-80.
- C. Type 1, Class 150, Bronze, Horizontal Lift Check Valves: Bronze body with bronze disc and seat.
- D. Type 1, Class 150, Bronze, Vertical Lift Check Valves: Bronze body with bronze disc and seat.
- E. Type 3, Class 150, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.
- 2.6 GRAY-IRON SWING CHECK VALVES

A. Manufacturers:

1. Type I, Gray-Iron Swing Check Valves with Metal Seats:
- a. Cincinnati Valve Co.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Flomatic Valves.
 - f. Grinnell Corporation.
 - g. Hammond Valve.
 - h. Kitz Corporation of America.
 - i. Legend Valve & Fitting, Inc.
 - j. Milwaukee Valve Company.
 - k. Mueller Co.

- l. NIBCO INC.
 - m. Powell, Wm. Co.
 - n. Red-White Valve Corp.
 - o. Walworth Co.
 - p. Watts Industries, Inc.; Water Products Div.
- 2. Type II, Gray-Iron Swing Check Valves with Composition to Metal Seats:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Div.
 - c. Mueller Co.
 - d. Watts Industries, Inc.; Water Products Div.
- B. Gray-Iron Swing Check Valves, General: MSS SP-71.
- C. Type I, Class 250, gray-iron, swing check valves with metal seats.
- D. Type II, Class 250, gray-iron, swing check valves with composition to metal seats.

2.7 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Manufacturers:

- 1. Type I, Wafer Lift-Disc Check Valves:
 - a. Mueller Steam Specialty.
- 2. Type II, Compact-Wafer, Lift-Disc Check Valves:
 - a. Durabla Fluid Technology, Inc.
 - b. Flomatic Valves.
 - c. GA Industries, Inc.
 - d. Grinnell Corporation.
 - e. Hammond Valve.
 - f. Metraflex Co.
 - g. Milwaukee Valve Company.
 - h. Mueller Steam Specialty.
 - i. Multiplex Manufacturing Co.
 - j. NIBCO INC.
 - k. SSI Equipment, Inc.
 - l. Val-Matic Valve & Mfg. Corp.
 - m. Valve and Primer Corp.
- 3. Type III, Globe Lift-Disc Check Valves:
 - a. Durabla Fluid Technology, Inc.
 - b. Flomatic Valves.
 - c. GA Industries, Inc.
 - d. Grinnell Corporation.
 - e. Hammond Valve.
 - f. Metraflex Co.
 - g. Milwaukee Valve Company.
 - h. Multiplex Manufacturing Co.
 - i. NIBCO INC.
 - j. SSI Equipment, Inc.
 - k. Val-Matic Valve & Mfg. Corp.

1. Valve and Primer Corp.
 4. Type IV, Threaded Lift-Disc Check Valves:
 - a. Check-All Valve Mfg. Co.
 - b. Durabla Fluid Technology, Inc.
 - c. Grinnell Corporation.
 - d. Legend Valve & Fitting, Inc.
 - e. Metraflex Co.
 - f. Milwaukee Valve Company.
 - g. Mueller Steam Specialty.
 - h. NIBCO INC.
 - i. Watts Industries, Inc.; Water Products Div.
 - B. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.
 - C. Type I, Class 250, Wafer Lift-Disc Check Valves: Wafer style with cast-iron shell with diameter matching companion flanges.
 - D. Type II, Class 250, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle.
 - E. Type III, Class 250, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends.
 - F. Type IV, Class 150, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends.
- 2.8 BRONZE GATE VALVES
- A. Manufacturers:
 1. Type 1, Bronze, Non-rising-Stem Gate Valves:
 - a. American Valve, Inc.
 - b. Cincinnati Valve Co.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Crane Co.; Crane Valve Group; Jenkins Valves.
 - e. Crane Co.; Crane Valve Group; Stockham Div.
 - f. Grinnell Corporation.
 - g. Hammond Valve.
 - h. Kitz Corporation of America.
 - i. Legend Valve & Fitting, Inc.
 - j. Milwaukee Valve Company.
 - k. NIBCO INC.
 - l. Powell, Wm. Co.
 - m. Red-White Valve Corp.
 - n. Walworth Co.
 - o. Watts Industries, Inc.; Water Products Div.
 2. Type 2, Bronze, Rising-Stem, Solid-Wedge Gate Valves:
 - a. American Valve, Inc.
 - b. Cincinnati Valve Co.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Crane Co.; Crane Valve Group; Jenkins Valves.

- e. Crane Co.; Crane Valve Group; Stockham Div.
 - f. Grinnell Corporation.
 - g. Hammond Valve.
 - h. Kitz Corporation of America.
 - i. Milwaukee Valve Company.
 - j. NIBCO INC.
 - k. Powell, Wm. Co.
 - l. Red-White Valve Corp.
 - m. Walworth Co.
3. Type 3, Bronze, Rising-Stem, Split-Wedge Gate Valves:
- a. Cincinnati Valve Co.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Grinnell Corporation.
 - d. NIBCO INC.
- B. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy hand wheel.
- C. Type 1, Class 150, Bronze Gate Valves: Bronze body with non-rising stem and bronze solid wedge.
- D. Type 1, Class 200, Bronze Gate Valves: Bronze body with nonrising stem and bronze solid wedge.
- E. Type 2, Class 150, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge.
- F. Type 2, Class 200, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge.
- 2.9 CAST-IRON GATE VALVES
- A. Manufacturers:
1. Type I, Cast-Iron, Nonrising-Stem Gate Valves:
- a. Cincinnati Valve Co.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Grinnell Corporation.
 - f. Hammond Valve.
 - g. Kitz Corporation of America.
 - h. Legend Valve & Fitting, Inc.
 - i. Milwaukee Valve Company.
 - j. NIBCO INC.
 - k. Powell, Wm. Co.
 - l. Red-White Valve Corp.
 - m. Walworth Co.
 - n. Watts Industries, Inc.; Water Products Div.
2. Type I, Cast-Iron, Rising-Stem Gate Valves:
- a. Cincinnati Valve Co.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Grinnell Corporation.
 - f. Hammond Valve.

- g. Kitz Corporation of America.
 - h. Legend Valve & Fitting, Inc.
 - i. Milwaukee Valve Company.
 - j. NIBCO INC.
 - k. Powell, Wm. Co.
 - l. Red-White Valve Corp.
 - m. Walworth Co.
 - n. Watts Industries, Inc.; Water Products Div.
- B. Cast-Iron Gate Valves, General: MSS SP-70, Type I.
- C. Class 250, NRS, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, non-rising stem, and solid-wedge disc.
- D. Class 250, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid-wedge disc.
- E. Class 250, NRS, All-Iron, Cast-Iron Gate Valves: Cast-iron body with cast-iron trim, non-rising stem, and solid-wedge disc.
- F. Class 250, OS&Y, All-Iron, Cast-Iron Gate Valves: Cast-iron body with cast-iron trim, rising stem, and solid-wedge disc.

2.10 BRONZE GLOBE VALVES

- A. Manufacturers:
- 1. Type 1, Bronze Globe Valves with Metal Disc:
 - a. Cincinnati Valve Co.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Grinnell Corporation.
 - f. Hammond Valve.
 - g. Kitz Corporation of America.
 - h. Legend Valve & Fitting, Inc.
 - i. Milwaukee Valve Company.
 - j. NIBCO INC.
 - k. Powell, Wm. Co.
 - l. Red-White Valve Corp.
 - m. Walworth Co.
 - 2. Type 3, Bronze Globe Valves with Renewable Seat and Metal Disc:
 - a. Cincinnati Valve Co.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Grinnell Corporation.
 - f. Hammond Valve.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Walworth Co.
- B. Bronze Globe Valves, General: MSS SP-80, with ferrous-alloy hand wheel.

- C. Type 1, Class 150, Bronze Globe Valves: Bronze body with bronze disc.
- D. Type 1, Class 200, Bronze Globe Valves: Bronze body with bronze disc.
- E. Type 2, Class 150, Bronze Globe Valves: Bronze body with PTFE or TFE disc.
- F. Type 2, Class 200, Bronze Globe Valves: Bronze body with PTFE or TFE disc.
- G. Type 3, Class 150, Bronze Globe Valves: Bronze body with bronze disc and renewable seat.
- H. Type 3, Class 200, Bronze Globe Valves: Bronze body with bronze disc and renewable seat.

2.11 CAST-IRON GLOBE VALVES

A. Manufacturers:

1. Type I, Cast-Iron Globe Valves with Metal Seats:

- a. Cincinnati Valve Co.
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Crane Co.; Crane Valve Group; Jenkins Valves.
- d. Crane Co.; Crane Valve Group; Stockham Div.
- e. Grinnell Corporation.
- f. Hammond Valve.
- g. Kitz Corporation of America.
- h. Milwaukee Valve Company.
- i. NIBCO INC.
- j. Powell, Wm. Co.
- k. Red-White Valve Corp.
- l. Walworth Co.

B. Cast-Iron Globe Valves, General: MSS SP-85.

C. Type I, Class 125, Cast-Iron Globe Valves: Gray-iron body with bronze seats.

D. Type I, Class 250, Cast-Iron Globe Valves: Gray-iron body with bronze seats.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly, or gate valves.
 - 2. Throttling Service: Angle, ball, butterfly, or globe valves.
 - 3. Pump Discharge: Spring-loaded, lift-disc check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Low-Pressure, Compressed-Air Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller: One-piece, 400-psig CWP rating, copper alloy.

2. Equipment-Isolation Ball Valves, NPS 2 and Smaller: Safety-exhaust, bronze.
3. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
4. Lift Check Valves, NPS 2 and Smaller: Type 2, Class 150, horizontal or vertical, bronze.
5. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.
6. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 250, gray iron.
7. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 150.
8. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type II or Class 250, cast iron, I.
9. Gate Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
10. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 250, NRS, bronze-mounted cast iron.
11. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
12. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 250, bronze-mounted cast iron.

D. Domestic Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: One-piece, 400-psig CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Butterfly Valves, NPS 2-1/2 and Larger: Flangeless or Single-flange, 150-psig CWP rating, ferrous alloy, with EPDM liner.
4. Lift Check Valves, NPS 2 and Smaller: Type 2, Class 150, horizontal or vertical, bronze.
5. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150 200, bronze.
6. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 250, gray iron.
7. Wafer Check Valves, NPS 2-1/2 and Larger: Single-plate, wafer, Class 125 or 150, ferrous alloy.
8. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 150.
9. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type II or Class 250, cast iron.
10. Gate Valves, NPS 2 and Smaller: Type 1, Class 150, bronze.
11. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 250, NRS, bronze-mounted cast iron.
12. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
13. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 250, bronze-mounted cast iron.

E. Low-Pressure Steam Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: One-piece, 400-psig CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.
4. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
5. Gate Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
6. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, NRS, bronze-mounted cast iron.
7. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
8. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

F. Steam Condensate Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: One-piece, 400-psig CWP rating, copper alloy.
2. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.
3. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 250, gray iron.
4. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 150.
5. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type I or II, Class 250, cast iron.
6. Gate Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
7. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 250, NRS, bronze-mounted cast iron.
8. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
9. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 250, bronze-mounted cast iron.

G. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water, steam, and steam condensate services.

2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.2 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install check valves for proper direction of flow and as follows:
 1. Swing Check Valves: In horizontal position with hinge pin level.
 2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
 3. Lift Check Valves: With stem upright and plumb.

3.3 JOINT CONSTRUCTION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.4 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 15110

SECTION 15122 - METERS AND GAGES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following meters and gages for mechanical systems:

1. Thermometers.
2. Gages.
3. Test plugs.
4. Flowmeters.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 THERMOMETERS

A. Liquid-in-Glass Thermometers:

1. Manufacturers:
 - a. Ernst Gage Co.
 - b. Eugene Ernst Products Co.
 - c. Marsh Bellofram.
 - d. Miljoco Corp.
 - e. Trerice, H. O. Co.
 - f. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
 - g. Winters Instruments.
2. Case: Plastic, 7 inches long.
3. Tube: Red or blue reading, mercury or organic-liquid filled, with magnifying lens.
4. Tube Background: Satin-faced, non-reflective aluminum with permanently etched scale markings.
5. Window: Glass or plastic.
6. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
7. Stem: Metal, for thermo-well installation and of length to suit installation.
8. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

B. Bimetallic-Actuated Dial Thermometers:

1. Manufacturers:

- a. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
- b. Ernst Gage Co.
- c. Eugene Ernst Products Co.
- d. Marsh Bellofram.
- e. Miljoco Corp.
- f. NANMAC Corporation.
- g. Noshok, Inc.
- h. Palmer - Wahl Instruments Inc.
- i. REO TEMP Instrument Corporation.
- j. Tel-Tru Manufacturing Company.
- k. Terice, H. O. Co.
- l. Weiss Instruments, Inc.
- m. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- n. WIKA Instrument Corporation.
- o. Winters Instruments.

2. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.
3. Case: Dry type, stainless steel with 3-inch diameter.
4. Element: Bimetal coil.
5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass.
8. Ring: Stainless steel.
9. Connector: Adjustable angle type.
10. Stem: Metal, for thermo-well installation and of length to suit installation.
11. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

C. Thermo-wells:

1. Manufacturers: Same as manufacturer of thermometer being used.
2. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAGES

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
6. Marsh Bellofram.
7. Miljoco Corp.
8. Noshok, Inc.
9. Palmer - Wahl Instruments Inc.
10. REO TEMP Instrument Corporation.
11. Terice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Direct Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Liquid-filled type, drawn steel or cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass.
8. Ring: Metal.
9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.4 TEST PLUGS

A. Manufacturers:

1. Flow Design, Inc.
2. MG Piping Products Co.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.
6. Terice, H. O. Co.
7. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

2.5 FLOWMETERS

A. Wafer-Orifice Flow meters:

1. Manufacturers:

- a. ABB, Inc.; ABB Instrumentation.
- b. Armstrong Pumps, Inc.
- c. Badger Meter, Inc.; Industrial Div.
- d. Bell & Gossett; ITT Industries.

- e. Meriam Instruments Div.; Scott Fetzer Co.
 - f. Daniels
2. Description: Differential-pressure-design orifice insert for installation between pipe flanges; with calibrated flow-measuring element, separate flow meter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flow meter, and system fluid.
 3. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated name-plate.
 4. Pressure Rating: 300 psig.
 5. Temperature Rating: 400 °F.
 6. Range: Flow range of flow-measuring element and flow meter shall cover operating range of equipment or system served.
 7. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flow meter element, and having 6-inch- diameter, or equivalent, dial with fittings and copper tubing for connecting to flow meter element.
 - a. Scale: pounds per hour.
 - b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of range.
 8. Operating Instructions: Include complete instructions with each flow meter.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

- A. Install thermometers in the following locations:
 1. Inlet and outlet of each hydronic boiler and chiller.
- B. Provide the following temperature ranges for thermometers:
 1. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
 2. Steam and Condensate: 50 to 400 deg F, with 5-degree scale divisions.

3.2 GAGE APPLICATIONS

- A. Install pressure gages for discharge of each pressure-reducing valve.
- B. Install pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install thermo-wells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.
- C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most read-able position.
- D. Install needle valve and snubber fitting in piping for each pressure gage for fluids (except steam).
- E. Install needle valve and syphon fitting in piping for each pressure gage for steam.
- F. Install test plugs in tees in piping.

- G. Assemble and install connections, tubing, and accessories between flow-measuring elements and flow meters as prescribed by manufacturer's written instructions.
- H. Install flow meter elements in accessible positions in piping systems.
- I. Install differential-pressure-type flow meter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.
- J. Install wafer-orifice flow meter elements between pipe flanges.
- K. Install permanent indicators on walls or brackets in accessible and readable positions.
- L. Install connection fittings for attachment to portable indicators in accessible locations.
- M. Install flow meters at discharge of hydronic system pumps and at inlet of hydronic air coils.
- N. Mount meters on wall if accessible; if not, provide brackets to support meters.
- O. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.
- P. Calibrate meters according to manufacturer's written instructions, after installation.
- Q. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 15122

SECTION 15140 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes domestic water piping inside the building.
- B. See Division 15 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
- C. See Division 15 Section "Plumbing Specialties" for water distribution piping specialties.

1.2 SUBMITTALS

- A. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic, potable domestic water piping and components.
- B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- C. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Schedule 40, galvanized. Include ends matching joining method.
 - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body, with ball-and-socket, metal-to-metal, bronze seating surface and female threaded ends.
 - 3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
 - 4. Cast-Iron Flanges: ASME B16.1, Class 125.
 - 5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.
 - 6. Steel Piping, Expansion Joints: Compound, galvanized steel fitting with telescoping body and slip-pipe section. Include packing rings, packing, limit rods, chrome-plated finish on slip-pipe sections, and flanged ends.
 - 7. Steel Piping, Double Expansion Joints: Compound, galvanized steel fitting with telescoping body and two slip-pipe sections. Include packing rings, packing, limit rods, chrome-plated finish on slip-pipe sections, and flanged ends.

- D. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- E. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.2 VALVES

- A. Bronze and cast-iron, general-duty valves are specified in Division 15 Section "Valves."
- B. Balancing and drain valves are specified in Division 15 Section "Plumbing Specialties."

PART 3 - EXECUTION

3.1 PIPE AND FITTING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground piping, unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Domestic Water Piping on Service Side of Water Meter inside the Building: Use the following piping materials for each size range:
 - 1. NPS 4 to NPS 6: Steel pipe; gray-iron, threaded fittings; and threaded joints.
- E. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
 - 1. NPS 1 and Smaller: Hard copper tube, Type L or Type M; copper pressure fittings; and soldered joints.
 - 2. NPS 1-1/4 and NPS 1-1/2: Hard copper tube, Type L or Type M; copper pressure fittings; and soldered joints.
 - 3. NPS 2: Hard copper tube, Type L or Type M; copper pressure fittings; and soldered joints.
 - 4. NPS 2-1/2 to NPS 3-1/2: Hard copper tube, Type L or Type M; copper pressure fittings; and soldered joints.
 - 5. NPS 4 to NPS 6: Steel pipe; gray-iron, threaded fittings; and threaded joints.

3.2 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use bronze ball or gate valves for piping NPS 2 and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 3. Drain Duty: Hose-end drain valves.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
1. Install hose-end drain valves at low points in water mains, risers, and branches.
 2. Install stop-and-waste drain valves where indicated.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 15 Section "Meters and Gages," and drain valves and strainers are specified in Division 15 Section "Plumbing Specialties."
- D. Install domestic water piping level [with 0.25 percent slope downward toward drain] [without pitch] and plumb.
- E. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- C. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support devices are specified in Division 15 Section "Hangers and Supports." Install the following:
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 2. Individual, Straight, Horizontal Piping Runs: According to the following:

- a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
- 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 15 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6: 12 feet with 3/4-inch rod.
- F. Install supports for vertical steel piping every 15 feet.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 6. NPS 6: 10 feet with 5/8-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Install piping adjacent to equipment and machines to allow service and maintenance.
- B. Connect domestic water piping to water-service piping with shutoff valve, and extend and connect to the following:
 - 1. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 15 Section "Plumbing Fixtures."
 - 2. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean and disinfect potable domestic water piping using purging and disinfecting procedures prescribed by authorities having jurisdiction.
- B. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities.

END OF SECTION 15140

SECTION 15182 - STEAM AND CONDENSATE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following for LP steam (less than 15 psig) and condensate piping:

1. Pipe and fittings.
2. Strainers.
3. Safety valves.
4. Pressure-reducing valves.
5. Steam traps.
6. Thermostatic air vents and vacuum breakers.

1.2 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:

1. LP Steam Piping: 15-psig and below
2. HP Steam Piping: above 15-psig
3. Condensate Piping: 100-psig at 250 deg F.
4. Makeup-Water Piping: 80 psig at 250 deg F..
5. Blow down-Drain Piping: Equal to pressure of the piping system to which it is attached.
6. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.3 SUBMITTALS

A. Product Data: For each type of the following:

1. Pressure reducing and safety valve.
2. Steam trap.
3. Air vent and vacuum breaker.

B. Field quality-control test reports.

C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L or ASTM B 88, Type M.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. Wrought-Copper Fittings and Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.
- C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.
- E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

2.3 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries, International Inc.
 - d. Watts Water Technologies, Inc.
 - e. Zurn Plumbing Products Group.
 - 3. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

2.5 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 15 Section "Valves."
- B. Stop-Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide valves as part of the boiler by one of the following:
 - a. Crane Co.
 - b. Jenkins Valves; a Crane Company.
 - c. Lunkenheimer Valves.
 - d. A.Y. McDonald Mfg. Co.
 - 3. Body and Bonnet: Malleable iron.
 - 4. End Connections: Flanged.
 - 5. Disc: Cylindrical with removable liner and machined seat.
 - 6. Stem: Brass alloy.
 - 7. Operator: Outside screw and yoke with cast-iron hand wheel.
 - 8. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
 - 9. Pressure Class: 250.

2.6 STRAINERS

- A. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
 - 3. Strainer Screen: Stainless steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. Tapped blow off plug.
 - 5. CWP Rating: 250-psig working steam pressures.

2.7 SAFETY VALVES

- A. Bronze or Brass Safety Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - a. Armstrong International, Inc.
 - b. Kunkle Valve; a Tyco International Ltd. Company.
 - c. Spirax Sarco, Inc.
 - d. Watts Water Technologies, Inc.
 - 3. Disc Material: Forged copper alloy.
 - 4. End Connections: Threaded inlet and outlet.
 - 5. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
 - 6. Pressure Class: 250.

7. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - a. Armstrong International, Inc.
 - b. Kunkle Valve; a Tyco International Ltd. Company.
 - c. Spirax Sarco, Inc.
 - d. Watts Water Technologies, Inc.
3. Disc Material: Forged copper alloy with bronze nozzle.
4. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
5. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shut-off, factory set and sealed.
6. Pressure Class: 250.
7. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
8. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
9. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.8 PRESSURE-REDUCING VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 1. Armstrong International, Inc.
 2. Hoffman Specialty; Division of ITT Industries.
 3. Leslie Controls, Inc.
 4. Spence Engineering Company, Inc.
 5. Spirax Sarco, Inc.
- C. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.
- D. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.
- E. Body: Cast iron.
- F. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.
- G. Trim: Hardened stainless steel.
- H. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.
- I. Gaskets: Non-asbestos materials.

J. Capacities and Characteristics:

1. Refer to drawing schedules.

2.9 STEAM TRAPS

A. Thermostatic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - a. Armstrong International, Inc.
 - b. Barnes & Jones, Inc.
 - c. Dunham-Bush, Inc.
 - d. Hoffman Specialty; Division of ITT Industries.
 - e. Spirax Sarco, Inc.
 - f. Sterling.
3. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
4. Trap Type: Balanced-pressure.
5. Bellows: Stainless steel or monel.
6. Head and Seat: Replaceable, hardened stainless steel.
7. Pressure Class: 125.

B. Float and Thermostatic Traps:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - a. Armstrong International, Inc.
 - b. Barnes & Jones, Inc.
 - c. Dunham-Bush, Inc.
 - d. Hoffman Specialty; Division of ITT Industries.
 - e. Spirax Sarco, Inc.
 - f. Sterling.
4. Body and Bolted Cap: ASTM A 126, cast iron.
5. End Connections: Threaded.
6. Float Mechanism: Replaceable, stainless steel.
7. Head and Seat: Hardened stainless steel.
8. Trap Type: Balanced pressure.
9. Thermostatic Bellows: Stainless steel or monel.
10. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
11. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
12. Maximum Operating Pressure: 125 psig.

2.10 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - a. Armstrong International, Inc.
 - b. Barnes & Jones, Inc.
 - c. Dunham-Bush, Inc.
 - d. Hoffman Specialty; Division of ITT Industries.
 - e. Spirax Sarco, Inc.
 - f. Sterling.
4. Body: Cast iron, bronze, or stainless steel.
5. End Connections: Threaded.
6. Float, Valve, and Seat: Stainless steel.
7. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
8. Pressure Rating: 125 psig.
9. Maximum Temperature Rating: 350 deg F.

B. Vacuum Breakers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - a. Armstrong International, Inc.
 - b. Dunham-Bush, Inc.
 - c. Hoffman Specialty; Division of ITT Industries.
 - d. Johnson Corporation (The).
 - e. Spirax Sarco, Inc.
4. Body: Cast iron, bronze, or stainless steel.
5. End Connections: Threaded.
6. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
7. O-ring Seal: EPR.
8. Pressure Rating: 125 psig.
9. Maximum Temperature Rating: 350 deg F.

PART 3 - EXECUTION

3.1 LP and HP STEAM PIPING APPLICATIONS

- A. LP and HP Steam Piping: Schedule 40, Type E, Grade A, steel pipe; Class 150 cast-iron fittings; and threaded joints.
- B. Condensate Piping above Grade: Schedule 80, Type E, Grade A, steel pipe; Class 150 cast-iron fittings; and threaded joints.

- C. Condensate Piping below Grade: Schedule 80, Type E, Grade A, steel pipe; Class 150 cast-iron fittings; and threaded joints.

3.2 ANCILLARY PIPING APPLICATIONS

- A. Makeup-water piping installed above grade shall be the following:
 - 1. Drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
- B. Makeup-Water Piping Installed below Grade and within Slabs: Annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
- C. Blow down-Drain Piping: Same materials and joining methods as for piping specified for the service in which blow down drain is installed.
- D. Air-Vent Piping:
 - 1. Inlet: Same as service where installed.
 - 2. Outlet: Type K annealed-temper copper tubing with soldered or flared joints.
- E. Vacuum-Breaker Piping: Outlet, same as service where installed.
- F. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.3 VALVE APPLICATIONS

- A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
- B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.4 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.

- H. Install piping to allow application of insulation.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.
- M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.
- P. Install valves according to Division 15 Section "Valves."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blow down connection of strainers NPS 2 and larger. Match size of strainer blow off connection for strainers smaller than NPS 2.
- T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 15 Section "Pipe Expansion Fittings and Loops."
- U. Identify piping as specified in Division 15 Section "Mechanical Identification."
- V. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
 - 1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet.
 - 2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.

3.5 STEAM-TRAP INSTALLATION

- A. Install steam traps in accessible locations as close as possible to connected equipment.
- B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.6 PRESSURE-REDUCING VALVE INSTALLATION

- A. Install pressure-reducing valves in accessible location for maintenance and inspection.

- B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.
- C. Install gate valves on both sides of pressure-reducing valves.
- D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.
- E. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 15 Section "Meters and Gages."
- F. Install strainers upstream for pressure-reducing valve.
- G. Install safety valve downstream from pressure reducing valve station.

3.7 SAFETY VALVE INSTALLATION

- A. Install safety valves according to ASME B31.9, "Building Services Piping."
- B. Pipe safety-valve discharge without valves to atmosphere outside the building.
- C. Install drip pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.
- D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.8 HANGERS AND SUPPORTS

- A. Install hangers and supports according to Division 15 Section "Hangers and Supports." Comply with requirements below for maximum spacing.
- B. Seismic restraints are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
- D. Install hangers with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 9 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 9 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 4. NPS 2: Maximum span, 13 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2-1/2: Maximum span, 14 feet; minimum rod size, 3/8 inch.
 - 6. NPS 3: Maximum span, 15 feet; minimum rod size, 3/8 inch.
 - 7. NPS 4: Maximum span, 17 feet; minimum rod size, 1/2 inch.
- E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1/2: Maximum span, 4 feet; minimum rod size, 1/4 inch.
 - 2. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.

4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.9 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube," using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.10 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install traps and control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install vacuum breakers downstream from control valve, close to coil inlet connection.
- E. Install a drip leg at coil outlet.

3.11 FIELD QUALITY CONTROL

- A. Prepare steam and condensate piping according to ASME B31.9, "Building Services Piping," and as follows:
 1. Leave joints, including welds, un-insulated and exposed for examination during test.
 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on steam and condensate piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

C. Prepare written report of testing.

END OF SECTION 15182

SECTION 15189 - WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following heating plant water treatment systems:

1. Steam and condensate equipment and controls.
2. Chemical treatment test equipment.
3. Water treatment chemicals.

1.2 PERFORMANCE REQUIREMENTS

- A. Water quality for systems shall minimize corrosion and scale buildup for optimum efficiency of steam system equipment without creating a hazard to operating personnel or the environment.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: Power and control wiring.
- C. Field quality-control test reports.
- D. Other Informational Submittals:
1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
 2. Water Analysis: Illustrate water quality available at Project site.

1.4 QUALITY ASSURANCE

- A. Water-Treatment Service Provider Qualifications: An experienced heating plant water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 CHEMICAL TREATMENT SERVICE PROVIDERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Power Engineering Co.
 2. ONDEO Nalco Company.
 3. Equivalent as selected by owner's representative.

2.2 STEAM SYSTEM

- A. Sequestering agent and base treatment pumped from solution tank into boiler, with minimum of one pump per boiler.

2.3 CHEMICAL WATER TREATMENT SYSTEM

- A. Water treatment chemicals shall be fed on a percentage of makeup water for the deaerator and feed water to each of the boilers. Liquid sulfite shall be fed directly to the deaerator. Boiler treatment and condensate line treatment shall be fed into the boiler feed water line, downstream of the boiler feed water pumps and feed water valve.

2.4 EQUIPMENT FOR BOILERS

- A. Two (2) DEI ½ “ High temp motorized ball valves.
- B. Two (2) Parker (or equivalent) continuous blow down valves.
- C. Five (5) LMI A151-257 Chemical Metering Pumps mounted on freestanding frames.
- D. One (1) Walchem (or equivalent) Boiler Master Automatic Blow Down Controller. Provide all required surge protection and interlocks for proper operation of the controllers. Controller shall be supplied with Ethernet communication port and shall be capable of communicating with “eReports” web based data logging program. Three conductivity sensors and fittings will be provided with the controller.
- E. The web-based data-logging program shall be capable of producing treatment reports, trend reports for all parameters monitored and treatment used. The program shall be capable of accepting manual input for lab analysis, field analysis and coupon analysis. Access to the program shall be from the website and there shall be no software installed on the college computer system. All information in the website pertaining to Snow College will remain the property of Snow College and will be downloaded and presented to the owner at their request.
- F. One (1) Chemical Pump Control Panel. Panel shall be NEMA 12X Construction and shall include hand/off/auto switches and annunciator light for each pump. Pump control shall be provided from the blow down controller through the Pump Control Panel.
- G. One (1) Water Meter sized for Deaerator Make Up Water Line with a pulse signal
- H. Two (2) Seametrics 1” Turbine water meters to be installed in the boiler feed water line. One meter to be installed for each boiler. Each meter shall be wired to the blow down controller and shall initiate a pulse every 10 gallons.
- I. Five (5) Neptune QC-50 Injection Quills (or equivalent).
- J. Three (3) 65-gallon drum style treatment tanks mounted on secondary containment basin. Tanks to be interchangeable with replacements for product replenishment. Tanks shall be cross-linked HDPE and shall be provided in a natural color. Continuous level sensors shall be provided with each bulk tank. Level sensors shall be ultrasonic type and shall be capable of calibration and programming at the level sensor. Minimum resolution shall be 1/8". Sensors shall be interconnected with blow down controller for monitoring. Basin shall be manufactured to hold 110% of one treatment container. Basin shall be manufactured of polyethylene plastic.
- K. Two (2) Madden (or equivalent) sample coolers.
- L. Two (2) Keckley (or equivalent) blow down strainer style 1.

2.5 AUTOMATIC BLOW DOWN CONTROLLER

- A. Each Automatic blow down Controller shall include not less than 8 analog inputs, and 6 Digital inputs for system monitoring. Inputs for water meter connections shall be separate from the initial 8 digital inputs. Water meter from the make up lines of the dearator shall be connected and monitored by each controller. All analog inputs shall be 4-20 mA loops. Each controller shall provide two (2) sensing probes. The two sensors shall be installed on the two boilers associated with each control loop. The controller shall incorporate 8 output relays and shall be configured to monitor and control three (3) boilers (one (1) is future).

2.6 DIGITAL DISPLAY

- A. Controller shall include digital display and shall be programmed through the panel interface or through a local computer. RS232 or USB interface shall be provided on the controller for communication to a local computer for programming purposes. Data storage shall include all measured parameters and shall be stored at a minimum of 15-minute increments. Total data storage shall be held for not less than 30 days.

2.7 LEVEL MONITORS

- A. Level monitors shall be provided for the two (2) treatment containers with expandability to three (3). Levels of all treatments shall be monitored by the treatment controller, and shall be included in the alarm setup as a “call-out” alarm.

2.8 CONTROL

- A. A PECO (or equivalent) test kit shall be provided to include Titration type test kits and solutions, for determining Phenolphthalein and Methyl Purple Alkalinities, Total Hardness, Sodium Sulfite. Colorimetric test kits shall be provided for phosphonate and phosphate. A conductivity meter shall be provided to test for solids level in the boiler. The conductivity meter shall be Myron L model 532-M1. The test kit shall include all apparatus and reagents required to run the specified tests and shall be housed in a wall hung cabinet with light source.

2.9 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment.
- B. Water Softener Chemicals:
 - 1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.
 - 2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.
 - 3. Furnish chemicals recommended by water treatment system manufacturer for treating water to meet specified water quality. Provide only chemicals that are compatible with piping materials, seals, and accessories.
- C. Steam System Chemicals:
 - 1. Sequestering agent to reduce hardness and prevent feed line obstruction, base to provide alkalinity, oxygen scavenger, carbon dioxide neutralizer, and neutralizing amines.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install water-testing equipment on wall near water chemical application equipment.
- C. Install interconnecting control wiring for chemical treatment controls and sensors.
- D. Mount sensors and injectors in piping circuits.
- E. Blow down sensor; metering valve, and motorized ball valve shall be mounted with a three-valve bypass to isolate sensor and valves for servicing.
- F. The controller shall be mounted at a height appropriate for convenient visual inspection. Controller shall incorporate the latest in solid state/microprocessor technology. Controller enclosure shall be NEMA 12X. Communications ports must be separate to allow continuous monitoring by an onsite computer as well as continual connection to the network

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 15 Section "Valves."
- E. Refer to Division 15 Section "Domestic Water Piping Specialties" for backflow prevention required in makeup water connections to potable-water systems.
- F. Confirm applicable electrical requirements in Division 16 Sections for connecting electrical equipment.
- G. Ground equipment according to Division 16 Section "Grounding and Bonding."
- H. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 2. Monthly reports will be provided to the owner showing all monitored treatment parameters.
- C. All treatment materials will be delivered to the facility in portable containers, which will be used only to transport treatment to the bulk storage tanks, and then removed. No portable containers will be allowed to remain onsite.
- D. Tests and Inspections:
1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- E. Service Period
1. Provide chemicals and service program for startup of equipment, including the following:
 - a. Initial water analysis and recommendations.
 - b. Startup assistance.
 - c. Training of operating personnel.
 - d. Visits to test boiler water, and make necessary adjustments to the chemical feed system.
 - e. Log sheets.
 - f. Laboratory technical assistance.
 - g. Maintenance and repair of chemical feed equipment.
 - h. The owner shall provide treatment Chemical after the start up treatment is exhausted.
- F. Remove and replace malfunctioning units and retest as specified above.
- G. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
 2. Acidity and Alkalinity: ASTM D 1067.
 3. Iron: ASTM D 1068.
 4. Water Hardness: ASTM D 1126.

3.5 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris; repair damaged finishes, including chips, scratches, and abrasions.

- B. Ensure that system is operational, filled, started, and vented prior to cleaning. Place terminal control valves in OPEN position during cleaning. Use water meter to record capacity in each system.
- C. Add cleaning chemicals as recommended by manufacturer.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water-treatment systems and equipment.

3.7 OPERATION

- A. Solution pumps activated when feed water pumps are running and/or solution pumps activated from meter on makeup water.
- B. Conductivity controller samples boiler water on timed cycle and operates solenoid blow down valve in line to blow down tank.
- C. Continuous Liquid-level sensor, in each solution tank, deactivates solution pump and agitator, and signals alarm.

END OF SECTION 15189

SECTION 15194 - FUEL GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes fuel gas piping within the building. Products include the following:
 - 1. Pipe, tube, fittings, and joining materials.
 - 2. Protective pipe and fitting coating.
 - 3. Piping specialties.
 - 4. Specialty valves.
 - 5. Service meters.
 - 6. Pressure regulators.

1.2 PROJECT CONDITIONS

- A. Gas System Pressures: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 40-psig, and is reduced to secondary pressure of 25-psig or less.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NFPA Standard: Comply with NFPA 54, "National Fuel Gas Code."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Steel Pipe: ASTM A 53/A 53M; Type E or S; Grade B; black. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
4. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
5. Joint Compound and Tape: Suitable for natural gas.

2.3 PROTECTIVE COATING

- A. Furnish pipe and fittings with factory-applied, corrosion-resistant polyethylene coating for use in contact with materials that may corrode the pipe.

2.4 PIPING SPECIALTIES

- A. Flexible Connectors: ANSI Z21.24, copper alloy.
- B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

2.5 SPECIALTY VALVES

- A. Valve End Connections: Threaded, according to ASME B1.20.1.
- B. Appliance Connector Valves: ANSI Z21.15 and CSA International listed.
- C. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.
- D. Gas Valves: ASME B16.33 and CSA International-listed bronze body and 125-psig pressure rating.
- E. Automatic Gas Valves: ANSI Z21.21, with electrical operator for actuation by appliance automatic shutoff device.

1. Manufacturers:

- a. ASCO General Controls.
- b. ASCOELECTRIC, Ltd.
- c. ASCO Power Technologies, LP; Division of Emerson.
- d. Dungs, Karl, Inc.
- e. Eaton Corporation; Controls Div.
- f. Eclipse Combustion, Inc.
- g. GPS Gas Protection Systems Inc.
- h. Honeywell International Inc.
- i. Johnson Controls.

- F. Electrically Operated Gas Valves: UL 429, bronze, aluminum, or cast-iron body solenoid valve; 120-V ac, 60 Hz, Class B, continuous-duty molded coil. Include NEMA ISC 6, Type 4, coil enclosure and electrically opened and closed dual coils. Valve position shall normally be closed.

1. Manufacturers:

- a. ASCO General Controls.
- b. ASCO Power Technologies, LP; Division of Emerson.
- c. Dungs, Karl, Inc.
- d. Eclipse Combustion, Inc.

- e. Goyen Valve Corp.; Tyco Environmental Systems.
- f. Magnatrol Valve Corp.
- g. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
- h. Watts Industries, Inc.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.

3.2 PIPING APPLICATIONS

- A. Use flanges, unions, transition, and special fittings in applications below, unless otherwise indicated.
- B. Fuel Gas Piping:
 - 1. NPS 2 and Smaller: Steel pipe, malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 2-1/2 and Larger: Steel pipe, welded fittings.

3.3 VALVE APPLICATIONS

- A. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.
- B. Appliance Shutoff Valves for Pressure 0.5 to 25 psig: Gas stop or gas valve.
- C. Piping Line Valves, NPS 2 and Smaller: Gas valve.
- D. Valves at Service Meter, NPS 2 and Smaller: Gas valve.

3.4 INSTALLATION

- A. Basic piping installation requirements and piping joint construction are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Install pressure gage upstream and downstream from each service pressure regulator. Pressure gages are specified in Division 15 Section "Meters and Gages."
- C. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.
 - 1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
 - 2. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.
 - 3. In Walls: Gas piping with welded joints and protective wrapping specified in Part 2 "Protective Coating" Article may be installed in masonry walls, subject to approval of authorities having jurisdiction.
 - 4. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

- D. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
- E. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings unless specifically shown exposed to view.
- F. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.
- G. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- H. Connect branch piping from top or side of horizontal piping.
- I. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
- J. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.
- K. Install pressure gage upstream and downstream from each line pressure regulator. Pressure gages are specified in Division 15 Section "Meters and Gages."
- L. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.
- M. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support devices are specified in Division 15 Section "Hangers and Supports."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
- C. Install hangers for horizontal corrugated, stainless-steel tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/8 and NPS 1/2: Maximum span, 48 inches; minimum rod size, 3/8 inch.
 - 2. NPS 3/4 and NPS 1: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 - 3. Option: Support tubing from structure according to manufacturer's written instructions.

3.6 CONNECTIONS

- A. Install piping adjacent to appliances to allow service and maintenance. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

3.7 FIELD QUALITY CONTROL

- A. Test, inspect, and purge piping according to NFPA 54 and requirements of authorities having jurisdiction. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

END OF SECTION 15194

SECTION 15518 - FIRE-TUBE BOILERS

PART 1 - GENERAL

.1 RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

.2 SUMMARY

1. This Section includes packaged, factory-fabricated and -assembled, gas-fired, horizontal, fire-tube boilers, trim, and accessories for generating steam..

.3 SUBMITTALS

1. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other Work.
 - a. Wiring Diagrams: Detail power, signal, and control wiring.
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
3. Source quality-control test reports.
4. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
5. Startup service reports.
6. Operation and Maintenance Data: For fire-tube boilers to include in emergency, operation, and maintenance manuals.
7. Warranties: Special warranties specified in this Section.

.4 QUALITY ASSURANCE

1. Product Options: Drawings indicate size, profiles, and dimensional requirements of fire-tube boilers and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. ASME Compliance: Fabricate and label fire-tube boilers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
4. ASHRAE/IESNA 90.1 Compliance: Fire-tube boilers shall have minimum efficiency according to Table 10-8.

5. UL Compliance: Test fire-tube boilers to comply with UL 795, "Commercial-Industrial Gas Heating Equipment."
6. Boiler and burner to comply with UL, FM, IRI and CSD-1 requirements.
7. All small bore piping will be installed and hydrostatically tested at the factory to the first valve.

.5 COORDINATION

1. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

.6 WARRANTY

1. Horizontal Fire-Tube Boiler Performance-Efficiency Guarantee:
 - a. In the operating range from 25 to 100 percent, boiler efficiency shall be 83.6% thermal efficient. For each full percent of efficiency less than 82% thermal efficient, manufacturer shall pay Owner \$5000
 - b. Guarantee Period: Begins at completion of startup service.

PART 2 - PRODUCTS

.1 MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified:

.2 HORIZONTAL FIRE-TUBE BOILERS

A. Manufacturers:

1. Burnham Corporation.
2. Cleaver-Brooks; Div. of Aqua-Chem, Inc.
3. Hurst Boiler & Welding Company, Inc.
4. Superior Boiler Works, Inc.
5. Johnston Boiler Company

B. Description: Factory-fabricated, -assembled, and -tested fire-tube boilers with heat exchanger sealed pressure-tight, built on a steel base; including insulated jacket, flue-gas vent, water supply and return connections, and controls.

C. Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist boiler movement during a seismic event when boiler base is anchored to building structure.

D. Boiler Characteristics and Capacities:

1. Heating Medium: Steam.
2. Maximum Design Pressure Rating: 150 psig .
3. Operating Pressure: 100 psig

4. Steam Flow Rate: 17,250 **lb/h**
 5. Net Steam Rating: 12,995 MBH
 6. Minimum Efficiency: 83.6%
 7. Number of Passes: Four.
 8. Water Capacity: 2,817 gal.
 9. Gross Output Capacity: 16,738 MBh
 10. Boiler size: 500 Boiler Horsepower at site elevation of 5669 ft above sea level
- E. Pressure Vessel Design: Straight steel tubes rolled into steel headers. Four passes with wet-back design. Minimum heat-exchanger surface of **5 sq. ft./**. Include the following accessories:
1. Handholes for water-side inspections.
 2. Lifting lugs on top of boiler.
 3. Minimum **NPS 1 (DN 25)** hose-end drain valves at shell low point.
 4. Accessible drain and blowdown tappings, both high and low, for surface and mud removal.
 5. Tappings for steam supply, makeup, level controls, and chemical treatment.
- F. Front and Rear Doors: Hinged, sealed with heat-resistant gaskets and fastened with lugs and cap screws, and designed so tube sheets and flues are fully accessible for inspection or cleaning when doors are open. Include observation ports in doors at both ends of boiler for inspection of flame conditions. Insulation in door construction shall be accessible for inspection and maintenance.
- G. Casing:
1. Insulation: Minimum **2-inch** thick mineral-fiber insulation surrounding the boiler shell.
 2. Flue Connection: Flange at top of boiler with a locking quadrant heavy duty damper in the stack discharge to allow setting of boiler back pressure for job site conditions.
 3. Jacket: Sheet metal, with screw-fastened closures and baked-enamel protective finish.
 4. Mounting base to secure boiler to concrete base.
 5. Control Compartment Enclosure: NEMA 250, Type 1A.
- H. Stack Thermometer: Flue-gas thermometer having a minimum **5 inch-** diameter dial.
- .3 FORCED-DRAFT GAS BURNER
- A. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for natural
1. Gas Input: 20,922 MBH
- B. Turndown Ratio: Burner turndown to be minimum of 12 to 1
- C. Blower: Forward-curved, centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
1. Refer to Division 15 Section "Motors" for general requirements.
 2. Minimum Motor Sizes: 30 horsepower
 3. Electrical Characteristics: 480 V, three phase, 60 Hz.
- D. Gas Train: Control devices and modulating control sequence shall comply with requirements in IRI, FMG, ASME CSD-1, and UL.

- E. Pilot: electronic-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
- F. Flue-Gas Recirculation: Burner connections shall be equipped with recirculating flue gas line and FGR control valve, both factory installed.

- 1. Maximum Oxides of Nitrogen: 30 ppm. Guaranteed

.4 STEAM BOILER TRIM

- A. Include devices sized to comply with ANSI B31.1, "Power Piping"
- B. Pressure Controllers: Operating, firing rate, and high limit.
- C. Safety Relief Valve:
 - 1. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - a. Pressure Setting: 150 **psig**
 - 2. Bronze Safety Valves: Class 250, forged copper-alloy disc; fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
 - a. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
- D. Pressure Gage: Minimum 5-**inch** diameter, **0- to 150-psig** range.
- E. Water Column: Minimum **12-inch** glass gage with shutoff cocks.
- F. Drain Valves: Minimum **NPS 3/4** or nozzle size with hose-end connection.
- G. Blowdown Valves: Factory-installed bottom and surface, blowdown valves. Blowdown valves, two (2) quick and one (1) slow, acting as required by ANSI B31.1.
- H. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than **NPS 2** shall have rising stem.
- I. Stop-Check Valves: Furnish stop-check valve and stop valve for field installation at boiler outlet with free-blow drain valve for field installation between the two valves and visible when operating stop-check valve.
- J. Surface Blow-down: Surface blow-down to be automatic using skimmer tube with Boiler Matic 3000 TDS sensor to automatically sense rate of needed blow-down to open and close $\frac{3}{4}$ inch solenoid valve (included).

- K. Feedwater System: Boiler Feedwater system to be electronic modulation type utilizing a Triac Electronic System with a 1 inch electric feedwater valve, MM 193-7B low water cut off and level control, a 2-1/2 inch feedwater stop and check valve, a 2 inch 3-valve by pass valve arrangement and a control panel and potentiometer

.5 BURNER OPERATING CONTROLS

- A. Description: To maintain safe operating conditions, burner safety controls limit the operation of burner. Microprocessor-based control system integrates safety and operating controls utilizing a Siemens LMV 52 linkage-less electronic control system. Controller to control the gas valve, blower and FGR with no linkages. Controller to monitor and control the fuel - air ratios through the entire range of burner operation.
 - 1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design pressure
 - 2. Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
 - 3. Alarm Bell: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

.6 BOILER OPERATING CONTROLS

- A. Boiler operating controls shall include the following devices and features:
 - 1. Control Transformer: 115 V.
 - 2. Operating Pressure Control: Factory wired and mounted to control burner.
 - 3. Low-Water Cutoff and Pump Control: Control feedwater pump(s) for makeup water control.
 - 4. Sequence of Operation: Electric, factory-fabricated, and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
- B. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor and control steam pressure set point and display boiler status and alarms. Interface to be with existing Johnson Controls Metasys BMS. Interface to be installed for the entire boiler plant including on the new boiler #3 of this project and the two (2) Existing English water tube boilers. Other interface requirements for the plant include interface with the JC Metasys system of the deaerator system, feedwater systems, transfer pumps (2) , steam flow meters (3), and fuel oil tank.

.7 SOURCE QUALITY CONTROL

- A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code: Section I, for high-pressure boilers and Section IV, for low-pressure boilers.
- B. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

- C. Allow Owner access to source quality-control testing of fire-tube boilers. Notify Engineer 14 days in advance of testing.

PART 3 - EXECUTION

.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

.2 BOILER INSTALLATION

- A. Install boilers level on concrete base. Concrete base is specified in Division 15 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.
- B. Concrete Bases: Anchor boilers to concrete base.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around full perimeter of base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Cast-in-place concrete materials and placement requirements are specified in Division 3.
- C. Vibration Isolation: Rubber pads with a minimum static deflection of **0.25 inch**
- D. Install gas-fired boilers according to NFPA 54.
- E. Assemble and install boiler trim.
- F. Install electrical devices furnished with boiler but not specified to be factory mounted.

.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect gas piping full size to boiler gas-train inlet with union.

- C. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tapings with shutoff valve and union or flange at each connection.
- D. Install piping from safety relief valves to nearest floor drain.
- E. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- F. Connect breeching full size to boiler outlet. Refer to Division 15 Section "Breechings, Chimneys, and Stacks" for venting materials.
- G. Install piping adjacent to boiler to allow service and maintenance.
- H. Ground equipment according to Division 16 Section "Grounding and Bonding."
- I. Connect wiring according to Division 16 Section "Conductors and Cables."
- J. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to test, inspect, and adjust boiler components and equipment installation and to perform startup service.
- B. Perform installation and startup checks according to manufacturer's written instructions.
- C. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
- D. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
- E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Adjust initial temperature and pressure set points.
- G. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- H. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.
- I. Prepare written report that documents testing procedures and results.

.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-tube boilers. Refer to Division 1 Section "Closeout Procedures" [Demonstration and Training.]

END OF SECTION 15518

SECTION 15550 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Listed [single] [double]-wall [vents] [chimneys].

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Type L vents.
- B. Shop Drawings: For vents, breechings, chimneys, and stacks.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 LISTED TYPE L VENT

- A. Manufacturers:
 - 1. American Metal Products; MASCO Corporation.
 - 2. FAMCO.
 - 3. Heat-Fab Inc.
 - 4. Industrial Chimney Company.
 - 5. LSP Products Group, Inc.
 - 6. Metal-Fab, Inc.
 - 7. ProTech Systems Inc.
 - 8. Schebler Co. (The).
 - 9. Selkirk Inc.; Selkirk Metalbestos and Air Mate.
 - 10. Simpson Dura-Vent Co., Inc.; Subsidiary of Simpson Manufacturing Co.
 - 11. Tru-Flex Metal Hose Corp.
 - 12. Van-Packer Co.
- B. Description: Double-wall metal vents tested according to UL 641 and rated for 570 deg F (300 deg C) continuously, or 1700 deg F (926 deg C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 211 and suitable for low-heat appliances.
- C. Construction: Inner shell and outer jacket separated by at least a 2-inch airspace filled with high-temperature, ceramic-fiber insulation.
- D. Inner Shell: ASTM A 666, Type 304 stainless steel.
- E. Outer Jacket: Aluminized steel.

- F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

- 1. Termination: Stack cap designed to exclude 90 percent of rainfall.

PART 3 - EXECUTION

3.1 INSTALLATION OF LISTED VENTS AND CHIMNEYS

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

END OF SECTION 15550

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Common electrical installation requirements.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

- A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

1.4 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."
- D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 2. Pressure Plates: Plastic. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- D. Cut sleeves to length for mounting flush with both surfaces of walls.
- E. Extend sleeves installed in floors 2 inches above finished floor level.
- F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require a different clearance.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

- I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.
- J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- L. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

END OF SECTION 16050

SECTION 16060 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors, Green: Copper wire or cable insulated for 600 V.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad 5/8 by 96 inches in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors.
 - 3. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on incoming side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

END OF SECTION 16060

SECTION 16072 – ELECTRICAL SUPPORTS AND SEISMIC RESTRAINTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Seismic restraints for electrical equipment and systems.
 - 3. Construction requirements for concrete bases.

1.2 SUBMITTALS

- A. Product Data: Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

1.3 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.4 PROJECT CONDITIONS

- A. Site Class as Defined in the IBC: D.
- B. S_s , Mapped Maximum Considered Earthquake Spectral Response at Short Periods: 0.713.
- C. S_1 , Mapped Maximum Considered Earthquake Spectral Response at 1-Second Period: 0.209.
- D. Assigned Seismic Use Group or Building Category as Defined in the IBC III.
- E. Soil Profile Type: D.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed under this Project, with a minimum structural safety factor of five times the applied force.
- B. Steel Slotted Support Systems: Comply with MFMA-3, factory-fabricated components for field assembly, and provide finish suitable for the environment in which installed.

1. Available Manufacturers:

- a. Cooper B-Line; a division of Cooper Industries.
- b. ERICO International Corporation.
- c. Allied Support Systems; Power-Strut Unit.
- d. GS Metals Corp.
- e. Michigan Hanger Co., Inc.; O-Strut Div.
- f. National Pipe Hanger Corp.
- g. Thomas & Betts Corporation.
- h. Unistrut; Tyco International, Ltd.
- i. Wesanco, Inc.

2. Channel Dimensions: Selected for structural loading and applicable seismic forces.

C. Raceway and Cable Supports: As described in NECA 1.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Adhesive-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Available Manufacturers:

- (1) Hilti, Inc.
- (2) Powers Fasteners.
- (3) Simpson Strong-Tie Company, Inc.

2. Concrete Inserts: Steel or malleable-iron slotted-support-system units similar to MSS Type 18; complying with MFMA-3 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

4. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.

5. Toggle Bolts: All-steel springhead type.

6. Hanger Rods: Threaded steel.

2.3 SEISMIC-RESTRAINT COMPONENTS

A. Rated Strength, Features, and Application Requirements for Restraint Components: As defined in reports by an evaluation service member of the ICC Evaluation Service Program.

1. Structural Safety Factor: Strength in tension, shear, and pullout force of components used shall be at least five times the maximum seismic forces to which they will be subjected.

- B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.

2.4 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 for application of hangers and supports for electrical equipment and systems, unless requirements in this Section or applicable Code are stricter.

3.2 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.3 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and seismic criteria at Project.
- B. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so expansion anchors will be a minimum of 10 bolt diameters from edge of the base.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of the base.
 - 2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 6. Use 4000 PSI (27.6Mpa) 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF SEISMIC-RESTRAINT COMPONENTS

- A. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

- C. Restraint Cables: Provide slack within maximums recommended by manufacturer.
- D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Make flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic-control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to electrical equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

END OF SECTION 16072

SECTION 16075 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Identification for conductors and communication and control cable.
 - 2. Warning labels and signs.
 - 3. Equipment identification labels.

1.2 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

PART 2 - PRODUCTS

2.1 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Marker Tape: Vinyl or vinyl -cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.3 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a black background. Minimum letter height shall be 3/8 inch.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Auxiliary Electrical Systems Conductor and Cable Identification: Use marker tape to identify field-installed alarm, control, signal, sound, intercommunications, voice, and data wiring connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and cable pull points. Identify by system and circuit designation.
 - 2. Use system of designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
- B. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
 - 1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
 - 2. Equipment Requiring Workspace Clearance According to NFPA 70: Apply to door or cover of equipment.
- C. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, drilled for screw attachment.
 - c. Elevated Components: Increase sizes of labels and legend to those appropriate for viewing from the floor.
 - 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Electrical switchgear and switchboards.
 - c. Transformers.
 - d. Motor-control centers.
 - e. Disconnect switches.
 - f. Enclosed circuit breakers.
 - g. Motor starters.
 - h. Push-button stations.
 - i. Power transfer equipment.
 - j. Contactors.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.

- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - e. Ground: Green.
 - 2. 277/480-V Circuits:
 - a. Phase A: Yellow.
 - b. Phase B: Orange.
 - c. Phase C: Brown.
 - d. Neutral: Gray.
 - e. Ground: Green.

END OF SECTION 16075

SECTION 16120 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Sleeves and sleeve seals for cables.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW and SO.
- C. Multiconductor Cable: Comply with NEMA WC 70 for Type SO with ground wire.

2.2 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

- C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.4 SLEEVE SEALS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex Co.
 - 4. Pipeline Seal and Insulator, Inc.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 2. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.
- C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Coordinate first paragraph below with Division 2 Section "Underground Ducts and Utility Structures."
- E. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- H. Coordinate first paragraph below with Division 2 Section "Underground Ducts and Utility Structures."

- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- K. Class 1 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Install branch circuits and feeders exposed.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed conduits parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 16 Section "Electrical Supports and Seismic Restraints."
- F. Identify and color-code conductors and cables according to Division 16 Section "Electrical Identification."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- I. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

END OF SECTION 16120

SECTION 16130 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, details, and attachments to other work.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. RGS: Rigid Galvanized Steel Conduit: ANSI C80.1.
- B. IMC: Intermediate Metallic Conduit: ANSI C80.6.
- C. EMT: Electrical Metallic Tubing: ANSI C80.3.
- D. FMC: Zinc-coated steel flexible conduit.
- E. LFMC: Flexible steel conduit with PVC jacket.
- F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 - 2. Fittings for EMT: Set-screw or compression type.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. ENT: NEMA TC 13.
- B. RNC: NEMA TC 2, Type EPC-40-PVC.
- C. LFNC: UL 1660.
- D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type.
- E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

- A. Surface Metal Raceways: Steel with snap-on covers. Manufacturer's standard enamel finish.
- B. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. Retain one of two subparagraphs and list of manufacturers below. See Division 1 Section "Product Requirements."
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.
- C. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with manufacturer's standard colors.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Butler Manufacturing Company; Walker Division.
 - b. Enduro Systems, Inc.; Composite Products Division.
 - c. Hubbell Incorporated; Wiring Device-Kellems Division.
 - d. Lamson & Sessions; Carlon Electrical Products.
 - e. Panduit Corp.
 - f. Walker Systems, Inc.; Wiremold Company (The).
 - g. Wiremold Company (The); Electrical Sales Division.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy Type FD, with gasketed cover.
- C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

D. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.
2. Concealed Conduit, Aboveground: IMC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed: Rigid steel conduit
2. Concealed in Ceilings and Interior Walls and Partitions: EMT.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
4. Damp or Wet Locations: Rigid steel conduit.
5. Raceways for Optical Fiber or Communications Cable: **EMT**.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings.

3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit.

- G. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- H. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- I. Raceways for Optical Fiber and Communications Cable: Install as follows:
 - 1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- J. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 Section "Earthwork" for pipe less than 6 inches in nominal diameter.
 - 2. Install backfill as specified in Division 2 Section "Earthwork."
 - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."
 - 4. Install manufactured rigid steel conduit elbows for stub-ups at equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 - 5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.4 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

END OF SECTION 16130

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Snap switches.
 - 3. Communications outlets.
- B. See Division 16 Section "Voice and Data Communication Cabling" for workstation outlets.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 2. Leviton Mfg. Company Inc. (Leviton).
 - 3. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 15 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hubbell HBL5262.
 - b. Leviton; 5891 (single), 5352 (duplex).
 - c. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 15 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pass & Seymour; 2084.
 - b. Hubbell GF5262
 - c. Leviton

2.4 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hubbell; HBL1221 (single pole), HBL1222 (two pole), HBL1223 (three way), HBL1224 (four way).
 - b. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - c. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2.5 COMMUNICATIONS OUTLETS

A. Telephone Outlet:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 3560-6.
 - b. Leviton; 40649.
2. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1 complying with Category 5e. Comply with UL 1863.

2.6 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant die-cast aluminum with lockable cover.

2.7 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: Ivory.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
 - 1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

END OF SECTION 16140

SECTION 16410 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers.
 - 4. Enclosures.

1.2 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the specified manufacturers.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Available Manufacturers:
 - 1. Square D/Group Schneider.
- B. Fusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Nonfusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Available Manufacturers:

1. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
4. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.

C. Molded-Case Circuit-Breaker Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Indoor Locations NEMA 250, Type 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Division 16 Section "Seismic Controls for Electrical Work, Electrical Supports and Seismic Restraints."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."

3.2 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:

1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION 16410

SECTION 16511 – LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Lighting fixtures, lamps, and ballasts.
 - 2. Exit signs.
 - 3. Lighting fixture supports.

1.2 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. See Fixture Schedule on Drawing.
 - 3. Basis-of-Design Product: The design for each lighting fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- B. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

G. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 BALLASTS

A. Ballasts for Compact Fluorescent Lamps: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output.

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.95 or higher.
10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
11. Ballast Case Temperature: 75 deg C, maximum.

B. Internal-Type Emergency Fluorescent Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate 8 compact fluorescent lamps continuously at an output of 25,000 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

C. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.

2. Minimum Starting Temperature: Minus 20 deg F for single-lamp ballasts.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Open-circuit operation that will not reduce average life.
5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

2.4 EXIT SIGNS

- A. Internally Lighted Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.

2.5 LAMPS

- A. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500K, average rated life of 12,000 hours at 3 hours operation per start.

1. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).

- B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65 and color temperature 4000 K.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 16 Section "Electrical Supports and Seismic Restraints" for channel- and angle-iron supports and nonmetallic channel and angle supports.

- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Comply with NFPA 70 for minimum fixture supports.

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 16511